

# The National Agricultural Research Systems in the West Asia and North Africa Region



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International Center for Agricultural Research in the Dry Areas

## About ICARDA - FAO - AARINENA – CIHEAM

### **International Center for Agricultural Research in the Dry Areas (ICARDA):**

ICARDA serves the entire developing world for the improvement of lentil, barley and faba bean; all dry-area developing countries for the improvement of on-farm water-use efficiency, rangeland and small-ruminant production; and the West and Central Asia and North Africa region for the improvement of bread and durum wheats, chickpea, and farming systems. ICARDA's research provides global benefits of poverty alleviation through productivity improvements integrated with sustainable natural-resource management practices. ICARDA meets this challenge through research, training, and dissemination of information in partnership with the national agricultural research and development systems. The results of research are transferred through ICARDA's cooperation with national and regional research institutions, with universities and ministries of agriculture, and through the technical assistance and training provided by the Center. In addition to its role in supporting research through technical contributions and capacity building, it plays a catalytic role in enhancing regional and international cooperation. Its collaboration with the WANA NARS takes place through its regional programs in five sub-regions in WANA. National and regional coordination meetings are held annually to plan and review research in areas of common interest. ICARDA has 27 regional and sub-regional research networks in the WANA region, which address major agricultural problems and issues.

### **Food and Agriculture Organization of the United Nations (FAO):**

FAO works towards raising the levels of nutrition and the standards of living of peoples, securing improvements in the efficiency of the production and distribution of all food and agricultural products, and improving the conditions of rural populations, thus contributing towards an expanding world economy. Therefore, one of the major tasks of FAO is to ensure that the benefits of biotechnology will be shared by people in the North and South, in both large and small, and rich and poor countries. FAO's strategy is to concentrate on providing information, monitoring and advice; facilitating access to the new technologies; providing a forum for the review of trends; developing appropriate guidelines and codes to facilitate environmentally sound and equitable harnessing of modern biotechnology; helping developing countries to identify biotechnology needs and priorities and to assess socioeconomic impacts; and strengthening the overall biotechnological capabilities of the developing countries.

### **Association of Agricultural Research Institutions in the Near East and North Africa (AARINENA):**

AARINENA conducts its activities in five sub-regions in the Near East and North Africa: Maghreb, Nile Valley and Red Sea, Mashreq, Arabian Peninsula, and West and Central Asia. It aims to foster the development of agricultural research in the region; promote the exchange of agricultural, scientific and technical experience and information; encourage the establishment of appropriate cooperative research and training programs in accordance with identified regional, bilateral or national needs and priorities; advise member institutions on issues pertinent to research organization and management; and strengthen cross-linkages between national, regional and international research centers and organizations, including universities, through involvement in jointly planned research and training programs. AARINENA provides a good forum for conducting research at the regional level.

### **Centre International de Hautes Études Agronomiques Méditerranéennes (CIHEAM):**

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ICARDA - FAO - AARINENA - CIHEAM

**THE NATIONAL AGRICULTURAL RESEARCH  
SYSTEMS  
IN THE WEST ASIA AND NORTH AFRICA REGION**

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## FOREWORD

This study was initiated as a result of a joint agreement between the International Center for Agricultural Research in the Dry Areas (ICARDA), the Food and Agriculture Organization of the United Nations (FAO), the Association of Agricultural Research Institutions in the Near

precise, reliable, and updated information on the national agricultural research systems (NARSs) in the West Asia and North Africa (WANA) region which is essential for leaders of national and international scientific, technical and financial organizations concerned with agricultural research in the region for three main reasons.

- It will help the NARS leaders to better assess their own situation since a complete updated NARS presentation had not been available, and to enable them to compare their NARS with that of other countries.
- It should facilitate the development of international scientific collaboration among the NARSs and between the NARSs and the international scientific community, especially that of developed Mediterranean/European countries and of international and regional scientific/technical institutions (ICARDA, FAO, AARINENA, CIHEAM, ACSAD, AOAD, etc.) concerned with collaboration in agricultural sciences.
- It should focus the attention of national and international authorities on the large progress of the NARSs, especially of their main research institutes, observed over the past decades, and also on their more acute current weaknesses and constraints which need to be resolved in order to reinforce the capacity of the NARSs in supporting accelerated and sustainable agricultural development in the region through the generation of significant technical innovations and reliable knowledge on natural resources and rural socioeconomics.

Considering its regional programs and offices in the WANA sub-regions and its close interaction with the WANA NARSs, it was agreed that ICARDA would implement the study. The study was launched in February 1997 when Dr Joseph Casas, Research Director at the National Agricultural Research Institute (INRA) of France, was designated as its scientific leader. He was selected because of his extensive experience in NARS analysis and planning in developing countries, including countries in the WANA region, and his past experiences with CIHEAM (member of the Scientific Council), FAO (long collaboration with the Research and Technology Development Service), and ICARDA (member of the Board of Trustees).

During the initial months of the study (February-April 1997), the first drafts of the NARS monographs were prepared by national teams and were briefly presented at an

the Mediterranean and Near-East Count 7 May 1997, and organized by CIHEAM in collaboration with AARINENA, FAO, and ICARDA. This seminar offered the opportunity to review the advancement of the preparation of the monographs, to resolve some methodological issues, and to get feedback/comments from all participants, especially from the national teams or leaders.

After the seminar, a long process of extensive exchanges began as well as collaboration to complete the study. This process involved the national teams, Dr Joseph Casas, and ICARDA staff members, mainly Dr Mahmoud Solh, Assistant

Director General for International Cooperation, who insured constant follow-up of the study; Dr Hala Hafez, ICARDA Consultant, who improved, finalized and edited the publication and participated actively in preparing some of the monographs; and the Regional Coordinators: Dr Mohamed El Mourid (North Africa), Dr Nasri Haddad (Nile Valley and Red Sea), Dr Habib Halila (West Asia), Dr John Peacock (Arabian Peninsula), and Drs Habib Ketata, Suren P.S. Beniwal and Muhammed Tahir (Highlands).

A period of more than two years was necessary for preparing the publication in its present form. Although it appears to be a long time, it was required for developing the final versions of the monographs (presented in Chapters 4 to 8) in a satisfactory and harmonized form, and in a form that was fully acceptable to the NARSs, such that the monographs provide a concise, comprehensive, and critical view of the NARSs, their scientific and technical institutions, resources, research activities, and relations with development. It is worth mentioning that these final versions required an average of eight successive drafts, from which it was possible to present an accurate, sound cross-country analysis of these NARSs.

The results of this study, presented in this publication, were well worth the efforts put forth. We are confident that, in the future, they will serve the objectives mentioned above. However, it goes without saying that, in order to fully realize the intended benefits, the study should be periodically updated. The leading role in this regard will be taken by AARINENA.

On behalf of the various stakeholders, I would like to thank the NARS leaders and teams who participated in the study and to extend my appreciation to Dr Joseph Casas for the time and effort he dedicated to the study, as well as to Dr Mahmoud Solh, Dr Hala Hafez, and ICARDA Regional Coordinators for their valuable contribution to the study. Appreciation is also expressed to INRA/France for its support of the study and

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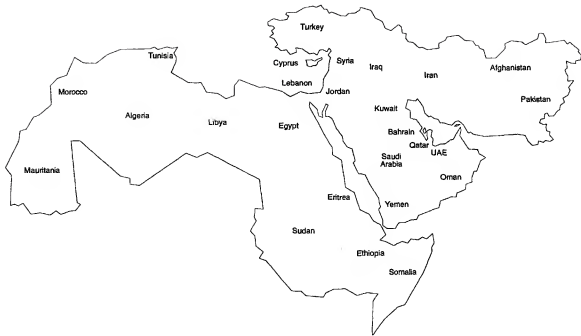
- Dr Gora Beye, succeeded in February 1999 by Dr Jacques Ekebil as Head, FAO Research and Technology Development Service, Rome; and Dr Abubaker Maddur, Senior Officer at this Service;
- Dr Abdelaziz Arifi (Director General, INRA, Morocco), succeeded in 1998 by Dr Mohammad H. Roozitalab (Deputy Head, AREEO, Iran) as Chairman, AARINENA; and
- Dr Enzo Chioccioli, Secretary General, and Dr Placido Plaza, Administrator General, CIHEAM, Paris.

Prof. Dr Adel El-Beltagy

Director General, ICARDA

## **Main Acronyms**

<b>AARINENA</b>	Association of Agricultural Research Institutions in the Near East and North Africa
<b>ACSAD</b>	Arab Center for Studies of the Arid Zones and Dry Lands
<b>AOAD</b>	Arab Organization for Agricultural Development
<b>CIHEAM</b>	
<b>CIMMYT</b>	Centro Internacional de Mejoramiento del Mais y del Trigo
<b>EU</b>	European Union
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>IARC</b>	International Agricultural Research Center
<b>ICARDA</b>	International Center for Agricultural Research in the Dry Areas
<b>ICRISAT</b>	International Crops Research Institute for the Semi-Arid Tropics
<b>IDRC</b>	International Development Research Center, Canada
<b>IFAD</b>	International Fund for Agricultural Development
<b>INRA</b>	Institut National de Recherche Agronomique, France
<b>ISNAR</b>	International Service for National Agricultural Research
<b>IWMI</b>	International Water Management Institute
<b>UNDP</b>	United Nations Development Programme
<b>USAID</b>	United States Agency for International Development
<b>AGDP</b>	Agricultural gross domestic product
<b>AR</b>	Agricultural research
<b>ARI</b>	Agricultural research institute
<b>FA</b>	Faculty of agriculture
<b>FAS</b>	Faculty of agricultural sciences
<b>FVM</b>	Faculty of veterinary medicine
<b>NARS</b>	National agricultural research system
<b>OCC</b>	Operation and capital costs (without salary costs)
<b>OI</b>	Other institution
<b>RY</b>	Research year (equivalent full-time researcher)
<b>pRY</b>	Potential research year
<b>aRY</b>	Actual research year
<b>STI</b>	Scientific and technical institution
<b>asm</b>	Academic staff member
<b>gsm</b>	Graduate staff member



**The West Asia and North Africa (WANA) region.**

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## SUMMARY

After a brief record of some basic data on the economy and agriculture of the West Asia and North Africa countries, which stresses on the strategic potential role of agricultural research for solving the difficult food challenges facing these countries at present and in the long term, the publication presents the methodology followed in the study. It then presents the monographs of the national agricultural research systems of the 18 participating countries: Algeria, Libya, Morocco, and Tunisia in North Africa; Egypt, Eritrea, Ethiopia, and Sudan in the Nile Valley and Red Sea sub-region; Cyprus, Iraq, Jordan, Lebanon, and Syria in West Asia; Iran and Turkey in the Highlands; and Bahrain, the United Arab Emirates, and Yemen in the Arabian Peninsula.

These monographs, prepared in 1998/99 by small, highly qualified national teams according to precise guidelines, have provided the background for a global and cross-country analysis, which demonstrated the large diversity of the national agricultural research systems, their structure, human and financial resources, research activities, and relations with development.

## EXECUTIVE SUMMARY

After a brief introduction to the study (Chapter 1), the publication presents a record of some basic data on the economy and agriculture of the West Asia and North Africa (WANA) countries, which stresses on the strategic potential role of agricultural research (AR) for solving the difficult food challenges facing these countries at present and in the long term (Chapter 2). The following chapters include the methodology used in preparing the monographs (Chapter 3) and then the monographs of the national AR systems (NARSs) of the 18 participating countries (Algeria, Libya, Morocco, and Tunisia in North Africa; Egypt, Eritrea, Ethiopia, and Sudan in the Nile Valley and Red Sea sub-region; Cyprus, Iraq, Jordan, Lebanon, and Syria in West Asia; Iran and Turkey in the Highlands; and Bahrain, the United Arab Emirates, and Yemen in the Arabian Peninsula) (Chapters 4 to 8).

These monographs, prepared in 1998/99 by small, highly qualified national teams according to precise guidelines, have provided the background for a comparative analysis of the NARSs, which covers their structure, human and financial resources, research activities, and relations with development (Chapter 9).

### Structure of the NARSs

The analysis of the NARS structure showed the following:

- The major role of the AR institutes (ARIs), which mobilize around 62% of the total potential research years (pRys or equivalent full-time researchers) and 78% of the total financial resources; the relative importance of the scientific potential of the faculties of agriculture and veterinary sciences (FASs) (23% of the total pRys) and their limited financial capacity (7% of the total financial resources); and the weak contribution of the other institutions ("general" research institutes, faculties of biology, agricultural development/service organizations, etc.).
- The rather high degree of concentration of the NARSs; the two largest institutions of each country gather 60% of the pRys and 72% of the financial resources of all the NARS (the latter percentage ranges from more than 88% in Cyprus, Ethiopia, and Lebanon to only 15% in Algeria).
- The moderate degree of national integration of the NARSs, which refers to the lack in many countries of a political and administrative authority able to coordinate the NARS institutions and to define/implement a national AR policy adapted to the social demands/needs and to the national and external resources available.
- The uneven territorial coverage by the NARS in a country of the country's large agroecological/administrative zones; this coverage is satisfactory in Eritrea, Ethiopia, Iraq, Syria, and Turkey; rather convenient in Iran, Libya, and Morocco; and highly unbalanced in Algeria, Egypt, Sudan, Tunisia, and Yemen, where large proportions of scientists and physical resources are concentrated in and around the capital and in the most favored agricultural zones.

This structural analysis leads to a tentative typology of the NARSSs according to their size and structure (see Chapter 9, Table 3), which shows the large diversity of the NARSSs in the WANA region, each country having a specific structural profile with only few similarities among the different countries.

## **Human and Financial Resources**

### Human Resources

More than 38,000 graduate staff members (gsm), including 99% nationals and 1% expatriates, are engaged in AR activities. They represent about 18,000 pRYs, of which around 6,700 (37%) are in Egypt, 3600 (20%) in Iran, 2300 (13%) in Turkey, and 5,400 (30%) in the other countries.

The qualifications of the NARS gsm are highly variable according to category of institutions and country. They are: (i) rather low at the ARIs (26, 24, and 50% of the national gsm are PhD, MS, and BS holders, respectively), with a wide range among the countries (from around 50% PhD holders in Cyprus and Egypt, to less than 9% PhD holders in Eritrea, Iran, Libya, Syria, and the United Arab Emirates); and (ii) rather high at the FASSs (54, 29, and 17% of the national gsm are PhD, MS, and BS holders, respectively). If we consider—as most of the countries do—that research can be implemented efficiently only by the PhD holders and young MS holders preparing PhD degrees, it would be realistic to assume that only about 50% of the 18,000 pRYs of the WANA region are really able to undertake AR activities.

In almost all countries, differences of qualifications at the ARIs and FASSs result from the much better career and salary schemes offered in the past—and still often prevailing (except in Egypt, Ethiopia, Lebanon, Morocco, Tunisia)—to academic staff members, which may reflect the higher priority given to university education than to research. Researchers' salaries are generally much lower than in the private sector. However, except in Syria and Turkey, they are relatively high compared with the average income per capita, especially in Eritrea, Ethiopia, Morocco, and Tunisia.

In all countries, AR institutes suffer a more or less strong imbalance in the numbers of support staff. Numbers of technicians are very insufficient in most countries (including some countries such as Egypt, Jordan, Libya, Syria, and Turkey, where BS holders are acting as technicians). Less-qualified support staff (clerks, laborers, drivers, etc.) are excessively numerous in most countries but exceptionally few in Libya and Morocco. Most of the ARIs also complain about the low quality of this support staff, especially technicians, mainly due to the very low salaries which discourage good candidates, the limited opportunities for upgrading, and the budget constraints. Highly qualified administrative staff is very scarce at most of the ARIs. At the FASSs, the previous imbalances are generally more acute: technicians and other support staff are very few and are mobilized to support teaching activities.

### Financial Resources

The total financial resources or expenditures (TE) allocated to AR in the 18 WANA countries amount to around US\$ 412 million for the year 1997/98, consisting of

- US\$ 376 million funded by the countries (91% of TE), mainly comprised of public/budgetary allocations from the government (with few self-generated resources coming from research contracts funded by national public and private organizations; seed production, soil analyses, socioeconomic studies, etc.);
- US\$ 17 million from loans, mainly provided by the World Bank, taken up by a few countries (Jordan, Morocco, Tunisia, Turkey, Yemen); and
- US\$ 19 million granted by national and international donors or agencies.

These resources amount to US\$ 110 million in Turkey, 99 in Iran, 68 in Egypt, 40 in Morocco, and 95 for all the other NARSSs. A good number of NARSSs rely only on national resources (Algeria, Bahrain, Iran, Iraq, Libya, the United Arab Emirates). Foreign grants are higher than the national contributions in Eritrea and Yemen; they are relatively significant in Egypt, Ethiopia, and Jordan; and marginal in Cyprus, Lebanon, Morocco, Syria, Tunisia, and Turkey.

Areas of expenditure vary according to country and institution. In most of the NARSSs, ARIs allocate a large part of their financial resources to personnel expenses, and a small part to operational and capital costs (OCC), which are insufficient and often far from covering the research needs, resulting in a rather low rate of actual employment of the

researchers. In most of the countries, the FASSs have very limited funds for research, however, in some countries (Egypt, Morocco, etc.), academic staff members are involved in AR activities funded directly by ARIs and other organizations or through personal contracts or relations.

Many ARIs complain about the difficulties faced in managing their financial resources (actual public budgets often much under the agreed upon budgets and unstable over the years; frequent delays in fund liquidation; etc.). Most of the FASSs face an even harder situation, as they frequently do not have control of their financial resources.

### **Cross-Country Comparisons of the NARS Human and Financial Resources**

These comparisons relied on some significant ratios. One ratio is the actual employment rate (AER) of the scientific potential, which represents the ratio of total actual RYs (roughly estimated by taking into account different criteria, especially the available amount of OCC per pRY) to total potential RYs ( $AER = aRYs + pRYs$ ). AER, which constitutes the most comprehensive yardstick of the degree of "quantitative efficiency" of the NARSS, is rather low (36%) for the whole region, with large variations among countries. It is satisfactory (higher than 70%) in countries (Bahrain, Cyprus, Eritrea, Lebanon, Libya, Morocco) where the main ARIs and the FASSs enjoy good levels of OCC per pRY, through national and/or foreign funds. AER is very low (less than 30%) in other countries (Algeria, Egypt, Iran, Iraq, Sudan) where ARIs and FASSs have very limited OCC and academic staff members are marginally committed to AR activities.

The ratio of AR expenditures (national expenditures: NE, or total expenditures: TE) to agricultural gross domestic product (AGDP) is by far the most used criterion for cross-country comparisons. For the entire WANA region, average NE + AGDP and TE + AGDP were estimated at 0.41 and 0.45%, respectively, ranging from less than 0.1% (Sudan) to 6.4% (Bahrain), with intermediate values for other countries (NE + AGDP = around 0.20% in Lebanon and Yemen, 0.25% in Algeria, 0.28% in Syria, 0.36% in Turkey, 0.50% in Egypt and Iran, 0.68% in Morocco, etc.) (see Chapter 9, Table 10). Statistical analysis showed that there is no clear relation between the values of these ratios and the wealth (GDP per capita) or the size/population of the countries, which is unexpected since most of the similar previous studies related to other regions in the world revealed a strong positive correlation between AR expenditures and wealth of a country, on the one hand, and a negative correlation between expenditures and size/population of the country, on the other.

These ratios are much under the 1% or even 2% ratios recommended for developing countries by some international organizations (World Bank, European Union, IFPRI, etc.). However, these recommended ratios are questionable for several reasons exposed in the study and are undoubtedly too high and unrealistic for the WANA countries with middle and low incomes per capita.

### **Research Activities**

#### Research Management Processes

Few countries (Eritrea, Iraq, Jordan, Lebanon, Tunisia, Yemen) have prepared formal AR national long- and/or medium-term plans, including priority-setting exercises and allocation of resources by research domains or programs. In most of the other countries, AR national plans have been included as brief components of national economic development plans. Among these other countries, the largest national ARIs (INRA/Morocco, ARC/Egypt, GDAR and GDRS/Turkey, etc.) have often designed master plans or implemented programming processes in order to guide strategic decisions on research programs and resource allocation. Few FASSs (Eritrea, Turkey) have started to establish research priority areas.

In most countries, monitoring and evaluation processes have been more or less efficient. However, many national AR plans, master plans and programming/priority-setting exercises have often induced only limited changes in research programs and resource allocation.

#### Research Programs

Information related with the characteristics of the research programs and their scientific dissemination is rather fragmented and uneven in many NARSS. Small NARSS and the Algerian NARS (as a medium-size, very fragmented, and weakly integrated NARS) face difficulties in organizing programs endowed with the essential resources required for achieving significant results; in these countries, as well in most of the FASSs of the WANA region, research programs are mainly conducted on an individual basis. In the medium and large NARSS (except Ethiopia),



overlapping of research programs is frequent (more frequent in the highly fragmented and moderately or weakly integrated NARSS: Algeria, Egypt, Iran, Iraq, Morocco, Syria, Tunisia, Turkey).

In many monographs, some characteristics are also mentioned for the main ARIs.

- Priority is given to applied and adaptive research. Only a few NARSS (mainly Egypt, Morocco, Turkey) are currently involved in modern sciences with wide use of biotechnology, isotopes, remote sensing, expert systems, and computers.
- Frequently, there is secondary emphasis on forestry, animal production, food technology, and economy. Research programs on crops and natural resources are generally the most established and better covered.
- Permanent research teams on farming systems are few; however, significant efforts in that field have been made in some countries (Eritrea, Jordan, Morocco, Tunisia) and initiated in others (Algeria, Egypt, Iraq, Sudan, Syria, Turkey). However, in countries (mainly Algeria, Iran, Libya, Sudan) with ARIs covering crops, animal production, and natural resources separately, implementation of farming systems research remains difficult.

From the monographs, it is difficult to form a reasonable judgment of the scientific productivity (quantity and quality) of the NARSS. The low rates of actual employment of the human scientific potential and the insufficient weight given to scientific achievements in terms of their influence on the researchers' careers in many countries suggest that this scientific productivity is, in general, rather modest given the large numbers of agricultural scientists in the WANA region. This statement is consistent with the fact that publication policies (scientific papers, journals, books, bulletins) seem rather active and sustained only in very few countries (Egypt, Morocco, Tunisia, Turkey).

### **International Scientific Linkages**

Scientific collaboration with national institutions of developed countries and international organizations is active and diversified in Egypt, Eritrea, Jordan, and Yemen, which are countries that benefit from rather large external financial support (grants and loans). It is also rather well developed in Ethiopia and Morocco, but remains moderate or limited in Bahrain, Lebanon, Syria, Tunisia, Turkey, and the United Arab Emirates, and poor in Algeria, Iran, Libya, and Sudan. In those latter countries, relatively isolated for political or internal reasons, international AR centers (particularly ICARDA) are basically the only windows to the international scientific community.

Scientific cooperation between the WANA NARSS is rather limited and mainly active through networks managed or funded by international/regional organizations (mainly CIHEAM, FAO and ICARDA) and financial agencies (IFAD, the World Bank, etc.).

### **Relations with Development**

Channels for relationships between NARS institutions and development organizations vary from country to another and are relatively numerous and diversified (participation of representatives of public and private development organizations in the management and research committees; research contracts with these development organizations; services such as soil/water analysis, soil mapping; on-farm research; workshops; training courses; information packages for extension services and farmers; etc.). These channels seem rather well organized or have largely improved over the last years in the main ARIs of Egypt, Iran, Iraq, Jordan, Lebanon, Morocco, Syria, Tunisia, Turkey, and Yemen. In most of the FASs, there is no formal institutional relationship with extension services or farmers and no mechanism for technology transfer, except in Egypt and Morocco.

In any case, whatever their degree of organization, the actual efficiency of these relationships depends on other objective factors related to the NARS features (structure; human, physical and financial resources; etc.) and to the national development/extension organizations. Actual linkages can only be globally weak in countries where NARS and/or development/extension organizations have acute weaknesses, i.e.:

- where NARSS (essentially their main ARIs) are highly fragmented and moderately or inadequately integrated (Algeria, Libya, Sudan); employing researchers with low qualifications (only few PhD holders) (Algeria, Bahrain, Eritrea, Iran, Libya, Syria, the United Arab Emirates); suffering strong unbalanced territorial allocation of resources, leaving large parts of the country without permanent significant human and physical resources (Algeria, Egypt, Sudan, Tunisia, Yemen); and mobilizing very limited financial resources (Algeria, Ethiopia, Sudan, Yemen);

- where development/extension organizations are poorly structured and/or have very limited qualified human resources and very low financial resources: this situation prevails in most countries except Jordan, Morocco, Tunisia, and Turkey.

Information provided in the monographs on the impact of the NARSSs on agricultural production and development is rather limited. To date, there have been no formal studies related to the impact of the NARSSs on agricultural production at the national level; a very limited number of studies conducted on some commodities in a few countries have generally demonstrated the high profitability of AR programs, but most of these studies have underestimated the research costs and overestimated the benefits and the AR profitability.

It is worth mentioning that over the period 1980–1996, no obvious relationship was found between the features of the NARSSs and the research–development linkages (as described above) on the one hand, and the performance of national agriculture estimated through the FAO agricultural production growth indices (total or per capita) (index = 100 in 1980) on the other:

- Some countries with NARSSs that have (or have had) numerous and acute deficiencies have registered rather good agricultural growth; among them are Iran (indices: total = 221; per cap. = 128), Algeria (FAO indices in 1996: total = 196, per capita = 126), and Lebanon (indices in 1996: total = 196, per cap. = 169).
- Other countries with better-structured and endowed NARSSs have had lower performance: Egypt (FAO indices in 1996: total = 181, per cap. = 123), Turkey (indices: total = 140, per cap. = 100), Ethiopia (indices: total = 138, per cap. = 88), Cyprus (indices: total = 105, per cap. = 83), and Eritrea (indices: total = 103, per cap. = 88).

In most countries, NARSSs may have actually achieved, until present, only a modest impact on national agricultural development due to their above-mentioned shortcomings and constraints, and to the weaknesses of the national development organizations and farmers' conditions and socioeconomic environment (agricultural policies, communications, etc.), which do not provide favorable circumstances for agricultural development and dissemination of innovations.

## Conclusion

The above analysis has shown the diversity of the NARS profiles in terms of structure, resources, research activities, and productivity, which reflects the diversity of the countries themselves. Despite this diversity, some common issues have been outlined, which deserve further attention within a historic perspective.

Most of the NARSSs are relatively young, have experienced very rapid growth, and have suffered unstable political and institutional changes in their environment over the years. In the past, and until present for some NARSSs, the ARIs and their researchers suffered discrimination compared to the FASs and their academic staff members, as priority was given to educating graduate staff members who were a rare resource in the past. But the situation has changed in most countries where most of the public agricultural institutions are now (or are starting to be) endowed with sufficient numbers of graduates. Therefore, the allocation of scientists at the ARIs is no more a sensitive issue, except when career and salary schemes are still much less favorable than at the FASs and some other public institutions, and may discourage recruitment and stability of the best researchers.

The unbalanced allocation of human and physical resources is a major issue in many NARSSs. The lack or scarcity of permanent scientific and technical staff in vast regions of most countries, which are often the less favorable agroecological zones and farming systems, results in unbalanced research activities and poor relations with development organizations in those regions. This situation reflects the national socioeconomic development policies which have generally paid more attention to urban development and to rural areas close to the capitals and large cities. Things are also improving in this domain, albeit rather slowly. Now, within the framework of political and economic decentralization processes which would allow more balanced regional development, and through the preparation of national AR strategic plans, NARSSs should improve the territorial allocation of their resources.

Insufficient financial resources, especially those allocated to operation and capital costs, are often considered as the most limiting factor to research efficiency. However, using the same available funds, research productivity could be improved through reducing the number of scientists (currently underemployed) and lower-qualified support staff, and reducing and rationalizing the networks of research centers and stations of the NARSSs.

Research activities are still frequently subject to many deficiencies (rather low qualifications of the scientists at the ARIs, unbalanced coverage of scientific domains and regions, lack of monitoring and assessment, limited

international scientific cooperation). The main ARIs are aware of these weaknesses and are progressively overcoming them through intensive training efforts, preparation of national strategic AR plans or ARI master plans, and dynamic relations with international AR centers and organizations.

Linkages with public and private development organizations are also concerns of the main ARIs, which have already set up diversified channels for intensifying them and increasing impact on agricultural production. Their improvement may rely on further changes within these organizations and in the national agricultural policies.

Finally, all these issues may be considered within a long-term perspective. Most of the NARSs have almost completed the stage of quantitative growth and are now entering into the era of consolidation. For the future, the major challenges to the NARSs will be the appropriate balance with their partner organizations—public agricultural administrations, public and private development organizations, and farmers' unions—which are facing more acute problems of management and resources. Countries certainly need well-organized and efficient NARSs, but such NARSs can not serve their purpose without partners having the same features. For reducing the gap, NARSs should pay higher attention to certain activities that could reinforce these partner organizations (such as training of their senior staff and leaders and temporary transfer of researchers to these organizations) and to some research domains which would help development and farmers' organizations to better understand their own situation and needs, such as research on farming systems and research on sociology of rural communities and organizations.

# **1. INTRODUCTION<sup>1</sup>**

## **1.1 SCOPE OF THE STUDY**

## **1.2 CONTENT OF THE PUBLICATION**

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<sup>1</sup> By **Dr Joseph Casas**, Research Director, INRA, Montpellier, France.



The purpose of this study was to review the current situation of the public national agricultural research systems (NARSs) in the West Asia and North Africa (WANA) region. This introductory chapter briefly summarizes the scope, objectives, and content of the study.

## 1.1 SCOPE OF THE STUDY

One may wonder about the interest in the WANA region and its public NARSs; what countries are geographically located in this region, why this region, why only the public NARSs and not the national private sector and international agricultural research (AR) institutions in the region, and why a new publication on these NARSs?

**What is the WANA region?** As the territorial borders of the region vary according to definitions by different international and regional organizations, it was decided to consider the narrow definition of FAO: "the region covers all the countries from Morocco to Iran including the 'traditional' Arab countries of North Africa (Algeria, Libya, Morocco, and Tunisia) and the Near East (Egypt, Iraq, Jordan, Lebanon, Syria, and the Arabian Peninsula countries), as well as the countries of West Asia (Afghanistan, Cyprus, Iran, and Turkey)." Depending on the studies, other countries are sometimes included in the region, such as Mauritania, the countries of the Nile Valley and Red Sea region (Sudan, Ethiopia, Eritrea, and Somalia), and Pakistan. As most of these other countries are generally considered within the sub-Saharan region, it was agreed to consider only the countries included in the narrow FAO definition and adding the countries of the Nile Valley and Red Sea region, leaving out Mauritania<sup>1</sup>, Somalia and Afghanistan (where political circumstances do not allow conducting AR activities), as well as Pakistan, generally attached to Southwest Asia<sup>2</sup>. This made a total of 22 countries to be considered.

**Why the WANA region?** It is a well-known fact that the agriculture and food sectors of the WANA region are globally facing difficult prospects in the long term, perhaps the most acute in the world, because of the very limited availability of natural resources (land and water) and the constant degradation of these resources, as well as the fast population growth. Overcoming these difficult challenges will be possible only through large-scale adoption of more productive and sustainable farming systems by farmers and herders without delay. To accomplish this, all public, professional, and private bodies involved in agricultural and rural development of the region (research, extension, training, credit, inputs, marketing, infrastructures, etc.) must be jointly mobilized. In this process, the AR national and international organizations concerned should play a major role through the generation and proposal of: (i) technical innovations adapted to the related physical and socioeconomic conditions and to the potential improvement of farmers' circumstances and of communication and infrastructure in rural areas, and (ii) reliable technical and socioeconomic information (soil maps, inventories of biological resources, surveys of farms and of agro-food marketing systems, etc.) necessary for supporting the definition and implementation of efficient national agricultural policies.

**Why only the public NARSs?** Public NARSs were chosen because they mobilize the bulk of the national AR effort; private AR is marginal or even absent in most of the countries. Public NARSs absorb much of the external assistance to this sector and are the favored partners of the international agricultural research centers (IARCs) and regional agricultural and AR institutions in the region, mainly ICARDA, based at Aleppo, Syria, and acting in most of the countries of the WANA region, and other IARCs (CIMMYT, CIP, ICRISAT, IWMI, IPGRI, ISNAR, etc.) based in some of these countries, as well as FAO, AOAD, etc. More could have been gained by also considering these international and regional institutions, but sufficient work on them has already been published, particularly by these institutions themselves and by the Consultative Group on International Agricultural Research (CGIAR). Nevertheless, brief information is given in the NARS monographs on private and international AR in each country.

**Why a new publication on these NARSs?** During the last 35 years, six<sup>3</sup> reviews related to the public NARSs in the WANA region have been published, and only three of them were concerned with all or a large part of the countries of the region: the studies published in 1990 by ISNAR (Hariri G.) related to the Arab countries, and FAO in 1990 (Abercrombie K.C., El Moursi A.W.) and AARENINA/FAO, both related to the Near East and North Africa.

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<sup>1</sup> Included in the 1993–1995 FAO study on the NARSs of West and Central Africa.

<sup>2</sup> The Pakistani NARS is oriented mainly towards irrigated regions and their commodities, with a limited scope of the western and semiarid zones where the AR Center of Qattah, with which ICARDA has developed strong collaboration in the past years, is located.

<sup>3</sup> See references at the end of Chapter 9. The three other publications are: FAO, 1964 (Watson J.M.), related to the Near East region (Afghanistan, Ethiopia, Iran, Iraq, Jordan, Lebanon, Libya, Pakistan, Sudan, Syria, United Arab Emirates); CIHEAM, 1988 (ed.: Casas J.), related to the countries of the Mediterranean region (North and South); and AOAD/ ISNAR/UNDP, 1994 (Hariri G.), related to selected Arab countries (Algeria, Iraq, Sudan, Yemen).

However, at present, they are well out-of-date, and although still of historical interest, they faced serious limitations as they were prepared without the direct participation of national leaders and presented very few precise data on the human and financial resources of the NARSs.

Given the previous considerations, the study aimed to take into account the public NARSs of the 22 WANA countries, which was an enormous challenge; however, 18 countries accepted to participate in the study; all countries except Kuwait, Oman, Qatar and Saudi Arabia, which did not show interest for diverse reasons.

## 1.2 CONTENT OF THE PUBLICATION

For the sake of readers who are not familiar with the WANA region, it seemed useful to briefly record (Chapter 2) some basic data on the economies and agricultural sectors of the WANA countries, which may assist in understanding the important potential role of the NARSs with respect to the hard challenges that most of these countries are currently facing, and possibly more so in the long term.

Chapter 3 is an introductory chapter, which gives an overview of the contents of the monographs and touches upon the methodology (concepts/definitions, conventions, tables) used in preparing them. Despite its abstract character, it is intended to help readers to better understand the monographs and to comprehend the main characteristics of each NARS.

The monographs are presented in Chapters 4 to 8, corresponding to the five sub-regions defined by ICARDA for its regional programs according to diverse criteria related to the countries, such as their geographical location and proximity, history, and similar agroecology. The sub-regions are:

- North Africa: Algeria, Libya, Morocco, and Tunisia;
- Nile Valley and Red Sea: Egypt, Eritrea, Ethiopia, and Sudan;
- West Asia: Cyprus, Iraq, Jordan, Lebanon, and Syria;
- Highlands: Iran and Turkey; and
- the Arabian Peninsula: Bahrain, the United Arab Emirates, and Yemen.

The monographs provided the background for the cross-country analysis, presented in Chapter 9, which is a tentative comparative regional analysis of the structure, human and financial resources, and other characteristics of the 18 NARSs.

It is worth mentioning that the content of the publication in its final form differs considerably from what was planned at the beginning of the study. In fact, the preliminary plan was to present the NARSs by sub-region, with an introductory chapter on the economies and agricultural sectors of the countries concerned, followed by the monographs and a brief cross-country analysis by sub-region. This seemed appropriate as it was expected that the NARSs of each sub-region would have some common features. But the global cross-country analysis (presented in Chapter 9) demonstrated the large diversity of the NARSs within every sub-region, indicating that little value would be gained from a cross-country analysis by sub-region. On the other hand, there appeared to be some similarities among NARSs belonging to different sub-regions.

The study refers essentially to the situation of the NARSs observed in 1997/98, with more recent data for some countries. However, it is more than a mere description and a static review of the NARSs in the reference years. All the monographs include a brief introductory chapter on the historical background of the NARSs, and for some countries for which previous national reviews were available, comparisons of their structure and resources were made between the current situation and the situation prevailing five or ten years ago<sup>1</sup>.

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<sup>1</sup> Even for these countries, comparisons were difficult because of the differences in methodologies and concepts and the frequent lack of attention in the previous national reviews given to the NARS institutions other than the specialized AR institutes.

## **2. ECONOMY AND AGRICULTURE OF THE WANA REGION: SOME BASIC DATA<sup>1</sup>**

### **2.1 BASIC DATA ON SOCIOECONOMY**

- 2.1.1 Demographic Features
- 2.1.2 Socioeconomic Features

### **2.2 MAIN FEATURES OF THE AGRICULTURAL SECTOR**

- 2.2.1 Role of the Agricultural Sector in the Regional and National Economies
- 2.2.2 Agricultural Performance

### **2.3 FARMING SYSTEMS CHARACTERISTICS AND CONSTRAINTS**

- 2.3.1 Farming Systems Characteristics
- 2.3.2 Limited Natural Resources: Major Constraints to Agricultural Development

### **2.4 CONCLUSION: THE CHALLENGING ROLE OF AGRICULTURAL RESEARCH**

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<sup>1</sup> By **Dr Joseph Casas**, Research Director, INRA, Montpellier, France.





The West Asia and North Africa (WANA) region consists of countries<sup>1</sup> that share, for the most part, a common cultural heritage and identity based on religion (Islam), language (Arabic), and historical background (mostly under the same broad rule in the past, basically the Roman, Umayyad, Abbasid, then Ottoman empires). In most of these countries, a Mediterranean climate prevails and, consequently, the countries share some common agricultural features. However, despite these common characteristics, they are currently very diverse, partly because of their distant and recent historical divergences and their specificities in agroecological conditions and natural resources, but mainly because of their size, population, and economic development.

This chapter presents the most significant socioeconomic features of the region (Section 2.1) and its most important agricultural characteristics (Section 2.2). Consideration of the dominant farming systems in the WANA region and their main constraints (Section 2.3), mainly related to the prevailing agroecological conditions, may justify the strategic role of agricultural research for the future development of the region<sup>2</sup>.

## 2.1 BASIC DATA ON SOCIOECONOMY

### 2.1.1 Demographic Features (Table 1)

The WANA region is currently (1996) the home of 431 million inhabitants. Since 1980 (277 million), the population has grown considerably. Although the annual rate of population growth has significantly decreased over the past years (from approximately 3% per year in the 1980s to 2.4% for the period 1995–2000), it remains rather high as it means an annual increase of about 10 million inhabitants during the previous 15 years.

All countries have faced a dramatic urbanization phenomenon: annual population growth in cities was higher than 4% in most countries during the period 1960–1994, but this rate has decreased very rapidly. In all the region, the urban population has surpassed the rural population, which still remains growing at a slower rate. In all countries, agriculture has to be more productive and more organized in order to satisfy the needs of the increasing number of urban people, concentrated generally in a few large towns<sup>3</sup>.

Demographic features are highly variable according to the countries. Egypt, Iran, and Turkey each have more than 60 million inhabitants; together with Ethiopia, they comprise 57% of the population of the WANA region; while Bahrain, Cyprus, Eritrea, Kuwait, Lebanon, Oman, Qatar, and the United Arab Emirates each have less than 4 million people. The growth rate of the population is under 2% in a few countries (Egypt, Cyprus, Lebanon, Morocco, Qatar, Tunisia, and Turkey), but still exceeds 3% in Eritrea, Jordan, Libya, Oman, Saudi Arabia, and Yemen. Urbanization trends are also varying from country to country<sup>4</sup>.

### 2.1.2 Socioeconomic Features (Table 2)

The gross national product (GDP) of the WANA region reaches around US\$ 790 billion (1996). Although it is less than that of the largest European countries (France, Germany, Italy, and the United Kingdom), when taking into account the cost of life and the related “parity income coefficient,” it is higher. The average GDP and “parity income” are US\$ 1,840 and 4,100 per capita, respectively. Dramatic improvements in this domain have also been made over the last two decades: GDP and GDP per capita have increased by more than 50% compared to those in 1980, as a result of economic development.

The economic features are very diverse in the WANA region and classification of the countries varies according to the criteria used.

<sup>1</sup> This chapter considers the 24 countries selected in Chapter 1 (see Section 1.1: What is the WANA region?), including those of North Africa (Algeria, Libya, Morocco, Tunisia), the Nile Valley and Red Sea sub-region (Egypt, Eritrea, Ethiopia, Sudan), West Asia (Cyprus, Iraq, Jordan, Lebanon, Syria), the “highland” countries (Iran, Turkey), and the Arabian Peninsula countries.

<sup>2</sup> Note: All statistical data used in this chapter come from international organizations (UNDP, World Bank, FAO). It is important to point out the rather high degree of approximation of these data for some countries (Iran, Iraq, Lebanon, Sudan, countries of the Arabian Peninsula), and sometimes their incoherence with data from national sources.

<sup>3</sup> The population of some capitals or other towns now (1996) exceeds 2 million: Cairo (9.9), Istanbul (8.1), Tehran (6.9), Baghdad (4.6), Algiers (3.9), Casablanca and Tripoli (each 3.4), Ankara (2.9), Riyadh (2.7), Khartoum (2.6), Addis Ababa (2.3), Tunis, Damascus and Aleppo (each around 2.1); most of these official data are most likely far below the actual ones.

<sup>4</sup> Ethiopia is still registering accelerated urbanization (annual urban growth rates of 4.7 and 5.2% during the periods 1960–1994 and 1994–2000, respectively). In Syria, urbanization has been keeping the same speed (4.4% over the two periods), while it is gradually slowing down in Jordan (4.9 and 4.7%), Oman (8 and 7.7%), Sudan (5.3 and 4.7%), and Yemen (6.8 and 6.6%). In the other countries, urbanization growth rate has notably decreased.

**Table 1 - The WANA Region: Total and Rural Population**
*Italics:* Approximate data. °: Rounded numbers. 0.-: Minimal (almost zero).

Country/ Sub-Region	Total Population (TP)			Annual Rate of Urbanization 1994-2000	Rural Population 1996	
	1980	1996	Increase 1995-2000			
	Million	Million	% per year	%	Million	%
1 Algeria	18.7	28.8	2.3	3.6	12.3	43
2 Libya	3.1	5.6	3.3	4.0	0.8	14
3 Morocco	19.4	27.0	1.8	3.0	13.8	51
4 Tunisia	6.4	9.2	1.8	2.7	3.9	42
<b>A North Africa</b>	<b>47.6</b>	<b>70.6</b>	<b>2.6</b>	<b>...</b>	<b>30.8</b>	<b>44</b>
5 Egypt	40.9	63.2	1.9	2.6	34.8	55
6 Eritrea	38.7	3.3	3.7	...	2.7	82
7 Ethiopia		58.2	3.2	5.2	50.1	86
8 Sudan	18.7	27.3	2.2	4.7	20.5	75
<b>B Nile Valley/Red Sea</b>	<b>98.3</b>	<b>152</b>	<b>2.3</b>	<b>...</b>	<b>108.1</b>	<b>71</b>
9 Cyprus	0.61	0.76	<i>1.2</i>	<i>2.0</i>	0.3	45
10 Iraq	13.0	20.6	2.8	3.6	2.5	25
11 Jordan	2.9	4.4	3.3	4.7	1.2	27
12 Lebanon	2.7	<i>3.1</i>	<i>1.8</i>	<i>2.9</i>	<i>0.4</i>	<i>12</i>
13 Syria	8.7	14.6	2.5	4.4	<i>6.9</i>	<i>47</i>
<b>C West Asia</b>	<b>27.9</b>	<b>43.5</b>	<b>2.6</b>	<b>...</b>	<b>11.3</b>	<b>26</b>
14 Iran	37.2	<i>61.1</i>	2.2	3.1	<i>24.4</i>	<i>40</i>
15 Turkey	44.5	61.8	1.6	3.7	17.9	29
<b>D Highlands</b>	<b>81.7</b>	<b>122.9</b>	<b>1.9</b>	<b>...</b>	<b>42.3</b>	<b>34</b>
16 Bahram	0.29	0.57	2.2	2.9	0.1°	9
17 Kuwait	1.37	1.7	3.0	0.5	0.-	2
18 Oman	0.99	2.3	4.2	7.7	2°	85
19 Qatar	0.21	0.56	1.8	2.2	0.-	8
20 Saudi Arabia	9.4	<i>18.8</i>	<i>3.4</i>	<i>3.6</i>	<i>3.6</i>	<i>19</i>
21 United Arab Emirates	0.75	2.26	2.0	2.7	0.3	15
22 Yemen	8.2	15.7	3.7	6.6	10.2	65
<b>E Arabian Peninsula</b>	<b>21.2</b>	<b>41.9</b>	<b>3.8</b>	<b>...</b>	<b>16.2</b>	<b>39</b>
<b>F Total WANA°</b>	<b>277</b>	<b>431</b>	<b>2.4</b>	<b>...</b>	<b>209</b>	<b>48</b>

Source: UNDP Human Development Report (1997); World Bank Atlas (1997); IMF, International Financial Statistics (1998).

**Table 2 - The WANA Region: Some Socioeconomic Data**

*Italics: Approximate data. °: Rounded numbers.*

Country/ Sub-Region	Total Population 1996 (million)	Gross Domestic Product (GDP) 1996					Human Develop. Index 1994	Total Poverty 1992 (% of population)	Rural Poverty 1992 (% of pop. living in rural areas)
		GDP (billion US\$)	GDP/cap (US\$)	Parity income coeffic. <sup>°</sup>	Parity GDP <sup>b</sup> (billion US\$)	Parity GDP/cap (US\$) <sup>°</sup>			
1 Algeria	28.8	43.4	1510	3.4	148	4550	0.74	22	53
2 Libya	5.6	25.0	4460	1.4	35	6240	0.80	24	22
3 Morocco	27.0	35.6	1320	2.8	100	3700	0.57	37	65
4 Tunisia	9.2	18.5	2010	2.6	48	5230	0.75	16	36
<b>A North Africa<sup>a</sup></b>	<b>70.6</b>	<b>122.5</b>	<b>1730</b>	<b>2.7</b>	<b>331</b>	<b>4680</b>	<b>0.68</b>	<b>27</b>	<b>56</b>
5 Egypt	63.2	67.9	1070	3.6	244	3850	0.61	22	61
6 Eritrea	3.3	0.58	180	5.3	3.1	950	0.27	65	92
7 Ethiopia	58.2	6.0	105	4.3	26	450	0.24	61	92
8 Sudan	27.3	7.8	285	3.8	30	1080	0.33	71	93
<b>B Nile Valley/Red Sea<sup>a</sup></b>	<b>152</b>	<b>82.3</b>	<b>540</b>	<b>3.6</b>	<b>303</b>	<b>1990</b>	<b>0.41</b>	<b>47</b>	<b>83</b>
9 Cyprus	0.76	9.2	12100	1.4	13	16900	0.91	16	26
10 Iraq	20.6	26.4	1280	2.5	66	3200	0.53	24	34
11 Jordan	4.4	7.2	1640	2.5	18	4100	0.73	17	29
12 Lebanon	3.1	13.3	4360	1.1	15	4800	0.79	20	17
13 Syria	14.6	16.4	1120	4.8	79	5380	0.76	39	68
<b>C West Asia<sup>a</sup></b>	<b>43.5</b>	<b>72.5</b>	<b>1670</b>	<b>2.6</b>	<b>191</b>	<b>4370</b>	<b>0.65</b>	<b>28</b>	<b>53</b>
14 Iran	61.1	93	1520	2.7	251	4100	0.78	25	48
15 Turkey	61.8	184	2980	2.1	386	6400	0.77	19	26
<b>D Highlands<sup>a</sup></b>	<b>122.9</b>	<b>277</b>	<b>2250</b>	<b>2.3</b>	<b>637</b>	<b>5190</b>	<b>0.77</b>	<b>22</b>	<b>39</b>
16 Bahrain	0.57	4.5	7890	1.7	7.7	13400	0.87	23	0
17 Kuwait	1.7	35.4	21100	1.1	39	23200	0.84	22	6
18 Oman	2.3	10.8	4700	1.7	18	7990	0.72	8	64
19 Qatar	0.56	6.5	11600	1.5	9.8	17400	0.84	25	28
20 Saudi Arabia	18.8	138	7300	1.3	179	9600	0.77	24	34
21 United Arab Emirates	2.26	36.3	16100	1.0	36	16100	0.87	23	24
22 Yemen	15.7	5.3	340	3.1	16	1050	0.36	27	72
<b>E Arabian Peninsula<sup>a</sup></b>	<b>41.9</b>	<b>236.8</b>	<b>5650</b>	<b>1.3</b>	<b>306</b>	<b>7330</b>	<b>0.63</b>	<b>24</b>	<b>59</b>
<b>F Total WANA<sup>°</sup></b>	<b>431</b>	<b>791</b>	<b>1840</b>	<b>2.2</b>	<b>1770</b>	<b>4100</b>	<b>0.60</b>	<b>32</b>	<b>67</b>
USA	265	7340	28000	1.0	7340	28000	0.94		
Japan	126	4650	40900	0.57	2650	23300	0.94		
Germany	82	2340	28900	0.73	1710	21100	0.92		
France	58	1530	26300	0.82	1250	21500	0.95		
Italy	57	1190	19880	1.0	1190	19880	0.92		
United Kingdom	59	1150	19600	1.02	1150	20000	0.93		
China	1215	807	750	4.4	3580	3330	0.63		
India	945	350	380	4.2	1460	1580	0.45		
Brazil	161	730	4400	1.44	1050	6340	0.78		
Mexico	93	320	3670	2.1	670	7660	0.85		

a. Figures for sub-regions and the WANA region related to GDP per capita, human development index and poverty are weighted by population.

b. Parity GDP: Its amount has been estimated by multiplying GDP by the parity income coefficient; this is correct for countries with limited international trade, but is questionable for the other countries, mainly the large oil exporters with rather high parity income coefficients (Bahrain, Iran, Saudi Arabia).

Source: First six columns: from (or calculated from) the World Bank Atlas (1997); IMF, International Financial Statistics (1998), Human Development Index: 1997 UNDP Human Development Report. Total and rural poverty : see Rodriguez (1997) who referred mainly to the 1997 and 1992 UNDP Human Development Reports.

- According to their GDP, Iran, Saudi Arabia, and Turkey are classified among the “very powerful” countries (GDP higher than US\$ 90 billion) and represent together around 52% of the GDP of the WANA region. Most of the other countries are considered as “relatively powerful” (GDP between US\$ 6 and 90 billion), except the “economically small” countries (GDP less than US\$ 6 billion): Bahrain, Ethiopia, and Yemen.
- According to their parity GDP per capita, the rich countries (parity GDP per capita higher than US\$ 8,000) are Cyprus and the large oil-exporting countries with small populations: Bahrain, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates, but parity GDP of Bahrain and Saudi Arabia (US\$ 13,400 and 17,400 per capita)—often recognized as very rich countries—is relatively far from that of the richest developed countries. Libya, Oman, and Turkey are sometimes also classified among the “high-income” countries (more than US\$ 6,000). All the other countries are generally considered as medium-income countries, except Eritrea, Ethiopia, Sudan, and Yemen, which are classified as low-income countries (parity GDP per capita lower than US\$ 1,500).

This classification may be refined according to the UNDP “human development index” (HDI), which takes into account life expectancy/longevity, education (adult literacy rate, rate of education at primary, secondary and university level), and parity GDP per capita. According to this index, the rich countries listed above and Libya are considered as having high human development (HDI higher than 0.80); most of the other countries are among the medium human developed countries (HDI between 0.50 and 0.79), except Eritrea, Ethiopia, Sudan and Yemen, which have low human development (HDI less than 0.50).

The UNDP “human poverty index,” which considers three other criteria (percentage of people who may die before the age of 40, percentage of illiterate people, social services available: health, drinking water, malnutrition affecting children less than 5 years old)<sup>1</sup>, provides a complementary vision of the social conditions prevailing in the WANA region. According to this indicator, an average of around 32% of the total population of the WANA region are poor, with percentages lower than 20% in Cyprus, Jordan, Oman, Tunisia, and Turkey; percentages higher than 60% in Eritrea, Ethiopia, and Sudan; and percentages between 20 and 40% in the other countries. In all countries except Bahrain, Kuwait, Lebanon, and Libya, poverty affects mainly the rural population, which is estimated at 67% of the total number of poor people in the WANA region, with the highest rate of poor rural people in the poorest countries (Eritrea, Ethiopia, Sudan, Yemen: more than 70% of the poor people are in rural areas) and in Syria, Oman, Egypt, and Morocco (68, 64, 61, and 53%, respectively)<sup>2</sup>.

According to the tentative classification proposed in [Table 3](#):

- Countries with high income per capita and high human development are Bahrain, Cyprus, Kuwait, Libya, Qatar, and the United Arab Emirates.
- Countries with high income per capita and medium human development are Oman, Saudi Arabia, and Turkey, Oman being remarkable for its low percentage of poor people (8%; the lowest in the WANA region).
- Countries with medium income per capita and medium human development are Algeria, Egypt, Iran, Iraq, Jordan, Lebanon, Morocco, Syria, and Tunisia; in this category, Morocco and Syria are the countries with the highest percentages of poor people (37 and 39%, respectively).
- Countries with low income per capita and low human development are Eritrea, Ethiopia, Sudan, and Yemen; Yemen in this group having a surprisingly low percentage of poor people (27%).

It is worth mentioning the socioeconomic diversity among the countries within the five sub-regions, mainly between those of the Nile Valley/Red Sea and Arabian Peninsula sub-regions.

## 2.2 MAIN FEATURES OF THE AGRICULTURAL SECTOR

This section considers the relative importance of the agricultural sector in the regional and national economies and provides some background on agricultural performance (national production, international trade, food supply).

<sup>1</sup> For HDI estimates, see Rodríguez (1997) who referred to the 1997 UNDP report and to other publications (Jazairi et al., 1992; Reardon and Vosti, 1995; UNDP 1992 report on human development).

<sup>2</sup> Rural areas (1996) are inhabited by around 92 million people out of the total 138 million poor people estimated for all the WANA region; among these 92 million poor rural people, 32.7 are in Ethiopia, 18 in Sudan, 8.5 in Egypt, 7.3 in Iran, 6.5 in Morocco, 3.9 in Syria, 3.4 in Algeria, 2 in Eritrea, 1.5 in Saudi Arabia (all values in million), and the remaining in the other countries.

**Table 3 - The WANA Region: Socioeconomic Classification of the Countries**

High income per capita: > US\$ 6000; Medium inc. per cap.: > US\$ 1500 and < US\$ 6000; Low inc. per cap.: < US\$ 1500.  
 High human development: > 0.80; Medium human devel.: > 0.50 and < 0.80; Low human devel.: < 0.50.

*Italics: Approximate data.*

Classification/ Country		Total Population 1996 (million)	Parity GDP/Cap. 1996 (US\$)	Human Develop. Index 1994	Total Poverty 1992 (% of popul.)
High Income per Capita and High Human Development	Kuwait	1.7	23200	0.84	22
	Qatar	0.56	17400	0.84	25
	Cyprus	0.76	16900	0.91	16
	United Arab Emirates	2.26	16100	0.87	23
	Bahrain	0.57	13400	0.87	23
	Libya	5.6	6240	0.80	24
High Income per Capita and Medium Human Development	Saudi Arabia	18.8	9600	0.77	24
	Oman	2.3	7990	0.72	8
	Turkey	61.8	6400	0.77	19
Medium Income per Capita and Medium Human Development	Syria	14.6	5380	0.76	39
	Tunisia	9.2	5230	0.75	16
	Lebanon	3.1	4800	0.79	20
	Algeria	28.8	4550	0.74	22
	Iran	61.1	4100	0.78	25
	Jordan	4.4	4100	0.73	17
	Egypt	63.2	3850	0.61	22
	Morocco	27.0	3700	0.57	37
	Iraq	20.6	3200	0.53	24
Low Income per Capita and Low Human Development	Sudan	27.3	1080	0.33	71
	Yemen	15.7	1050	0.36	27
	Eritrea	3.3	950	0.27	65
	Ethiopia	58.2	450	0.24	61

### **2.2.1 Role of the Agricultural Sector in the Regional and National Economies (Table 4)**

In all countries, the socioeconomic importance of the agricultural sector has rapidly declined in the last three decades and is still decreasing. Agriculture represents the most important sector in the WANA region in social terms as it still mobilizes an average of 42% of the labor force. This percentage exceeds 55% in some countries which are among the poorest: Eritrea, Ethiopia, Sudan, and Yemen. In Algeria, Egypt, Iran, Morocco, Syria, Tunisia, and Turkey, it ranges between 25 and 50%. The remaining countries, which include oil producers (Iraq, Libya, all the Arabian Peninsula countries except Oman and Yemen) and small countries (Cyprus, Jordan, Lebanon), agriculture is currently a marginal sector.

In the WANA region, the agricultural GDP (AGDP) currently totals around US\$ 110 billion and represents only 14% of the GDP<sup>1</sup>. With such a low AGDP, the average gross income of the agricultural population is relatively very low: it amounts to around US\$ 1,530 per agricultural laborer, against US\$ 6,880 per laborer in the other sectors (22% of the latter or 4.5 times less). In most countries, these differences result from the low productivity in agriculture, the low prices paid for food products, and the inadequate attention paid to agriculture by national economic policies.

Relative levels of agricultural incomes and productivity vary largely from country to another:

- Differences are very strong in the poorest countries (Eritrea, Ethiopia) and in richer countries (Morocco, Oman, Turkey, the United Arab Emirates) which are characterized by highly uneven urban and rural development.
- In Bahrain, Cyprus, Lebanon, and Kuwait, agricultural incomes are in line with the relative importance of the agricultural labor force in the country, as these countries enjoy flourishing intensified agriculture. Equal productivity and incomes also prevail in Libya and Syria, perhaps because of the efforts made recently to encourage agricultural production and reach food self-sufficiency.
- Iraq is the unique country where average agricultural incomes seem much higher than in other sectors, most likely as a result of the embargo since the Gulf war.

Agricultural exports are marginal (less than 10% of the total exports) in most countries, except in Jordan, Morocco, and Sudan (more than 40% of the total exports) and in Lebanon and Tunisia (around 20% of the total exports). Agricultural imports are important (more than 25% of the total import bill) in Algeria, Egypt, Iraq, Libya, Syria, and all the Arabian Peninsula countries (Mona, 1997) (see further).

The links of agriculture with the rest of the economy are still rather weak, but are rapidly improving. National agro-industrial sectors were very limited at the beginning of the 1990s (operating often with national and imported agricultural raw materials). According to the few statistical data available on agro-food industries (1999 Medagri Yearbook), in 1990, food industries represented 14% of the product (value) of all manufacturing industries in Turkey, 17% in Morocco, 19% in Iraq, 20% in Jordan, 23% in Egypt, 28% in Syria, and 46% in Yemen; however, added values of food industries were very low compared to the AGDP; the highest added value in the WANA region was observed in Turkey with only US\$ 3.4 billion, i.e., 12% of the current AGDP<sup>2</sup>. Dramatic progress may have occurred during the past years, mostly owing to investments by foreign and international enterprises involved in food processing (including beverages), food production, textiles, etc. The same evolution is reported (data not precise) for industries related to input production (seeds, pesticides, fertilizers, irrigation equipment, agricultural machinery).

Among the links of agriculture with the rest of the economy, it is worth mentioning the importance of food trade (including trade of locally prepared and sold food in restaurants and in the streets), generally implemented by individuals or very small family enterprises which often constitute an “informal” economy, for which few reliable data are available. In this respect, evolution may also be very rapid, with the recent presence of large national and foreign food enterprises (supermarkets, etc.) in some countries.

### **2.2.2 Agricultural Performance**

#### **WANA Region Overview**

Agricultural production (Table 4) - According to the FAO production index, the WANA region has registered during the period 1980–1996 rather high agricultural development: total production has grown by 85% (3.9% average growth per year, against 2.4% for the population) and by 14% per capita, mainly as a result of intensification (growth of irrigated areas and increased use of improved seeds, fertilizers, pesticides, mechanization, credit, etc.) (see further).

<sup>1</sup> The four largest European countries (France, Germany, Italy, Spain, and the United Kingdom) have together around the same AGDP (US\$ 112 billion in 1996), which represents 1.6% of their GDP; in these countries, the agricultural labor force represents around 2% of the total labor force.

<sup>2</sup> Other added values are: US\$ 1.1 billion in Egypt (8% of the 1996 AGDP), US\$ 0.6 billion in Syria, US\$ 0.1 billion in Jordan, and US\$ 0.17 billion in Cyprus (12, 15 and 17% of the 1996 AGDP for these three countries, respectively).

**Table 4 - The WANA Region: Some Data on Agriculture**
*Italics:* Approximate data. .... Data not available. %: Rounded numbers. 0... Minimal (almost zero).

Country/ Sub-Region	Agric. Labor Force (ALF)			Agric. GDP (AGDP) 1996		1996 Index of Incomes Agriculture: Other Sectors <sup>b</sup>	Ag. Production Index 1996/97: 1980 <sup>c</sup>		Ag. Exchanges 1996		1996 Index of Agric. Self- Sufficiency <sup>d</sup>
	1980	1996	ALF TLF <sup>a</sup>	AGDP	AGDP GDP				Exports E	Imports I	
	Million	Million	% 1996	Billion \$	%		Total	Per cap	Billion \$	Billion \$	
1 Algeria	1.35	2.3	25	5.4	12.4	41	194	126	0.1	2.7	68
2 Libya	0.14	0.12	7.5	2	8	107	121	65	0.05	1.3	62
3 Morocco	2.6	4.1	39	5.3	15	27	196	133	0.9	1.7	87
4 Tunisia	0.7	0.9	26	2.4	13.2	43	194	128	0.3	0.8	83
<b>A North Africa</b>	<b>4.8</b>	<b>7.4</b>	<b>30</b>	<b>15.1</b>	<b>12.3</b>	<b>33</b>	<b>189</b>	<b>124</b>	<b>1.3</b>	<b>6.5</b>	<b>75</b>
5 Egypt	5.1	8.4	36	12.1	19.2	42	181	123	0.5	3.9	78
6 Eritrea	14.1	1.3	79	0.11	20	7	103	88	0.1	2.3	5
7 Ethiopia		21.8	84	3.4	57	25	138	88	0.2	0.3	97
8 Sudan	4.3	6.8	64	3.1	40	38	145	95	0.6	0.3	111
<b>B Nile Val./Red Sea</b>	<b>24.7</b>	<b>38.3</b>	<b>63</b>	<b>18.5</b>	<b>23</b>	<b>18</b>	<b>156</b>	<b>104</b>	<b>1.4</b>	<b>6.8</b>	<b>77</b>
9 Cyprus	0.16	0.04	10	1	10	100	105	83	0.8	1	83
10 Iraq	1.1	0.7	12	7.9	30	310	125	77	0...	1	89
11 Jordan	0.7	0.16	13	0.6	8.1	59	259	126	0.2	0.7	55
12 Lebanon	0.1	0.1	11	1.6	12	110	196	169	0.1	1.2	59
13 Syria	0.8	1.3	30	4.9	30	100	167	93	0.8	0.8	100
<b>C West Asia</b>	<b>2.9</b>	<b>2.3</b>	<b>18</b>	<b>16</b>	<b>22</b>	<b>129</b>	<b>179</b>	<b>94</b>	<b>1.9</b>	<b>4.7</b>	<b>85</b>
14 Iran	4	6	29	20	22	61	221	128	1	3	91
15 Turkey	11	14	49	28	15.2	31	140	100	4.7	4.0	103
<b>D Highlands</b>	<b>15</b>	<b>20</b>	<b>32</b>	<b>48</b>	<b>17.3</b>	<b>44</b>	<b>183</b>	<b>115</b>	<b>5.7</b>	<b>7</b>	<b>97</b>
16 Bahrain	...	0.004	1.4	0.05	1	70	...	...	0...	0.3	14
17 Kuwait	...	0.007	1	0.4	1	100	147*	105*	0.03	1.1	27
18 Oman	0.14	0.25	39	0.4	4	7	...	...	0.2	0.8	40
19 Qatar	...	0.006	1.8	0.07	1	55	...	...	0.01	0.3	19
20 Saudi Arabia	1.3	0.8	13	9.7	7	50	470	232	0.4	4.3	71
21 UA Emirates	-	0.07	5.9	0.7	2	33	...	...	0.7	2.4	29
22 Yemen	1.2	2.7	55	0.9	17.6	18	137	73	0.1	0.8	56
<b>E Arab. Peninsula</b>	<b>2.7</b>	<b>3.8</b>	<b>29</b>	<b>12.2</b>	<b>4</b>	<b>10</b>	<b>310</b>	<b>157</b>	<b>1.4</b>	<b>10</b>	<b>59</b>
<b>F Total WANA<sup>e</sup></b>	<b>50</b>	<b>72</b>	<b>42</b>	<b>110</b>	<b>13.9</b>	<b>22</b>	<b>185</b>	<b>114</b>	<b>11.7</b>	<b>35</b>	<b>83</b>

a. TLF: Total labor force.

b. Index of Incomes Ag.: Other Sectors = Average inc. in agric. (AGDP ÷ ALF); Average inc. in other sectors (GDP – AGDP) ÷ (TLF – ALF).

c. FAO Agricultural Production Index (base = 100 in 1980).

d. Index of Agricultural Self-Sufficiency: AGDP ÷ National consumption (= AGDP + Imports – Exports).

Source: - ALF, TLF, ag. production index, ag. exchanges: FAO Production Yearbooks (1982 and 1997) and Trade Yearbook (1997).

- AGDP and GDP: Medagri 1995–1999 (CIEAM, Allay a); World Bank Atlas (1997); Atlaseco (1997–1999).

- Index of incomes and index of self-sufficiency: estimates from previous figures.



Agricultural growth has been uneven from country to another as indicated below:

- It has been remarkable in some countries: Saudi Arabia is in the top with a total 132% growth per capita over the period considered because of large investments made in irrigation schemes; agriculture in Lebanon (+69% growth per capita) has recovered a good level after its fall during the civil war; and Algeria, Egypt, Iran, Jordan, Morocco, and Tunisia have had sustained growth (around +25% per capita).
- Turkey and Kuwait have maintained the same level of production per capita during the last 16 years (1980–1996).
- Other countries suffered from a relatively strong deterioration of their agricultural production: Eritrea and Ethiopia (both –12% per capita), Iraq (–23%), Libya (–35%), and Yemen (–27%).
- Syria is a particular case as its agricultural growth per capita has been negative throughout the period (–7%), but positive since 1990<sup>1</sup>.

A more refined analysis of these figures would show that:

- In most countries, agricultural growth rate was slightly higher during the 1980s than later. This issue of long-term sustainability of agricultural development will be discussed further.
- Agricultural growth has been uneven among commodities: it has been strong in horticulture (vegetables and fruits), meat (mainly poultry, in all countries) and sugar, and insufficient in cereals, oilseeds and milk (Allaya, 1993; Nordblom and Shomo, 1995).

**Food imports/exports and self-sufficiency (Table 4)** - Despite its considerable development, agriculture has not been able to meet demand which is increasing rapidly (at an annual estimated rate of around 4 to 4.5%) because of both population and income growth. In the entire WANA region, imports (around US\$ 10 billion) in 1996 (a “normal” year) were much larger than exports (around US\$ 1.4 billion) and the net imports (imports – exports) represented around 17% of the net national consumption (e.g.: AGDP + imports – exports), which means a rate of agricultural self-sufficiency (RASS = AGDP: national net consumption) of 83%.

International trade is more or less balanced in pulses, potatoes, vegetables, fruits, and eggs. Net exports are concentrated mainly on fish. Net imports are primarily in cereals; the gap currently reaches more than 30 million tons per year (almost 30% of the consumption), which cost some US\$ 4.4 billion (of which US\$ 1.9 billion is for wheat, 0.7 for maize, 0.6 for rice, and 0.4 for barley); those imports could increase to 80 million tons in 2020 (El-Beltagy, 1997; Mona, 1997) and import growth would involve wheat as well as other cereals for animal feed as a result of the increasing demand for protein (Nordblom and Shomo, 1995). Net imports of refined sugar, fats and oils, milk, and meat are also relatively high (around 60, 55, 25 and 20% of the volumes consumed in the mid-1990s, respectively) (Allaya, 1993; Mona, 1997). Within the framework of liberalization of international trade, the rate of agricultural dependency of the WANA region is expected to grow in the future.

**Food consumption** - With such important net imports, the food diet has been not only maintained but slightly improved; from 1980 to 1996, calories per day per capita have increased from around 2,690 to 2,850 (+5.9%) (see Table 5), and consumption of proteins and lipids has grown at a much more significant rate (higher intake of meat, milk, and oils) (see Table 6).

### **Brief Country Analysis**

These global figures vary considerably according to country.

- Turkey and Sudan are the unique net exporting countries. In Turkey, net exports are very limited (US\$ 0.7 million, for a US\$ 28 million AGDP in 1996) and food diet is the highest in the WANA region (3,570 calories/day/capita). In Sudan, exports (mainly cotton) are relatively high, but at the expense of the food diet (only 2,390 calories/day/capita).
- Syria has presented, for a few years, an even agricultural and food imports/exports balance, with a satisfactory average food diet (3,340 calories/day/capita).
- Egypt, Tunisia, Cyprus, and Morocco are moderately dependent in their agricultural and food consumption (RASS estimated at around 78, 83, 83, and 87%, respectively) and have at the same time a satisfactory food diet (more than 3,200 calories/day/capita); these countries could balance their agricultural and food international trade with a food diet similar to the average in WANA (2,850 calories). Iran is also moderately dependent, with a “normal” diet (2,860 calories).

<sup>1</sup> The FAO agricultural production index is not available for Bahrain, Oman, Qatar, and the United Arab Emirates.

**Table 5 - The WANA Region: Food Diets (1980–1996)**
*Italics:* Approximate data. .... Data not available.

Country/ Sub-Region	Food Supply Calories/day/capita		Country/ Sub-Region	Food Supply Calories/day/capita	
	1980	1996		1980	1996
1 Algeria	2690	3020	14 Iran	2650	2860
2 Libya	3470	3130	15 Turkey	3240	3570
3 Morocco	2790	3240	<b>D Highlands</b>	<b>2980</b>	<b>3190</b>
4 Tunisia	2830	3250	16 Bahrain	....	....
<b>A North Africa</b>	<b>2720</b>	<b>3180</b>	17 Kuwait	2990	3080
5 Egypt	3000	3290	18 Oman	....	....
6 Eritrea	2960	1590	19 Qatar	....	....
7 Ethiopia	1810	1850	20 Saudi Arabia	2830	2740
8 Sudan	2200	2390	21 United Arab Emirates	3420	3370
<b>B Nile Valley/Red Sea</b>	<b>2400</b>	<b>2540</b>	22 Yemen	1950	2040
9 Cyprus	2920	3340	<b>E Arabian Peninsula<sup>a</sup></b>	<b>2960</b>	<b>2730</b>
10 Iraq	2770	2250	<b>F Total WANA</b>	2690	2850
11 Jordan	2690	2680			
12 Lebanon	2760	3280			
13 Syria	3110	3340			
<b>C West Asia</b>	<b>2820</b>	<b>2490</b>			

a. Average for Arabian Peninsula: estimates from the four countries 17, 19 to 22.

**Table 6 - The WANA Region: Food Diets in Selected Countries (1961–1996)**

Country	Year	Diet Components (calories or grams per day)			Consumption per Main Commodities (kg/capita/year)						
		Calories	Proteins	Lipids	Cereals	Food legumes	Oils and fats	Vegetables*	Fruits*	Meat	Milk
Algeria	1961	1740	48	32	140	2.1	6.6	23	57	12	47
	1996	3020	81	71	231	6.2	18	64	56	20	93
Libya	1961	1600	38	32	120	1.1	6.2	83	103	11	38
	1996	3130	72	113	194	4.6	30	98	78	24	75
Morocco	1961	2140	57	35	185	4.7	7.2	27	47	14	29
	1996	3240	86	59	266	7.4	15	80	85	16	29
Tunisia	1961	2070	56	41	165	2.5	9	87	55	12	40
	1996	3250	88	85	223	8.6	19	144	104	20	74
Egypt	1961	2280	63	42	180	7	7.4	105	68	12	32
	1996	3290	88	58	248	8.2	9.8	139	108	18	38
Sudan	1961	1780	54	53	105	5.5	5.7	33	44	21	90
	1996	2390	74	72	162	5.5	8.5	26	31	18	142
Iraq	1961	1830	51	41	120	3.1	6.6	125	100	13	69
	1996	2250	45	86	132	2.2	27.6	104	87	7.4	17
Jordan	1961	2200	56	48	150	6.6	8.4	82	57	6.6	35
	1996	2680	69	79	153	2.8	17	180	98	31	39
Lebanon	1961	2350	61	58	150	7.3	11	87	130	20	64
	1996	3280	83	107	138	14	22	233	263	32	86
Syria	1961	2310	62	56	175	5.4	9.9	93	108	10	68
	1996	3340	87	92	231	5.1	18	85	122	22	89
Turkey	1961	2820	89	69	200	9.5	12	121	177	17	180
	1996	3570	101	100	226	12	21	183	152	21	144
Yemen	1961	1730	50	30	155	6.3	3.5	28	48	8.4	25
	1996	2040	54	38	166	5.7	8	28	32	11	25

\*: First (1961) figures for vegetables and fruits are related to 1971 (data not available for 1961).

Sources for both tables: FAO Production Yearbooks and Medagri (CIHEAM, Allaya)  
(data not available for other countries for 1961 and 1996).

- Some countries are highly dependent; among these are the five small oil-exporting countries of the Arabian Peninsula (average RASS estimated at 29%), and Lebanon, Libya, and Algeria (RASS estimated at 59, 62 and 68%, respectively); however, the populations of these countries enjoy rather high-calorie food diets (more than 3,000 calories/day/capita). Jordan and Saudi Arabia are also highly dependent (RASS estimated at 55 and 71%), with the food diet slightly under the WANA average.
- Eritrea, Ethiopia, Yemen, and Iraq are facing the worst food situation (only 1,590, 1,850, 2,040, and 2,250 calories/day/capita, respectively), with very different profiles. Eritrea and Yemen rely heavily on food imports/grants<sup>1</sup>. Ethiopia is almost self-sufficient (very limited international exchange). In Iraq, the current moderate RASS is due to limitations of food imports (formerly very important) owing to the embargo.

Iraq, Jordan, and Libya are the unique WANA countries which have registered a slight deterioration in their food diet during the period 1991–1996, owing mainly to international political reasons<sup>2</sup>.

## 2.3 FARMING SYSTEMS CHARACTERISTICS AND CONSTRAINTS

### 2.3.1 Farming Systems Characteristics

#### Farming Systems and Agroecological Conditions

In the WANA region, most of the agricultural production is undertaken under a Mediterranean climate with dry summers and winter rainfall<sup>3</sup> which rarely exceeds 500 mm per year and highly fluctuates both within and between years. Agricultural production exhibits different features according to the major agroecological and farming systems: irrigated lands, favorable rainfed areas, marginal rainfed areas, and rangelands (see Table 8, first columns).

Irrigated lands, which cover around 27 million hectares (22% of the total 119 million ha arable lands), play an essential role as they probably produce more than 50% of the agricultural production of the WANA region<sup>4</sup>. Egypt and the small oil-exporting countries of the Arabian Peninsula are almost fully dependent on irrigation for their production. In Jordan, irrigated lands represent 60% of the arable lands and may contribute more than 90% of the output. In Iran, Iraq, Libya, Saudi Arabia, Sudan, Syria, Turkey, and Yemen, irrigated lands represent between 15 to 38% of the arable lands and are responsible for more than 60% of the AGDP. In most of those countries with relatively large irrigated schemes (Egypt, Iran, Iraq, Sudan, Syria, Turkey), irrigated farming systems are generally highly intensive and diversified, and include cereals, vegetables, fruit trees, and other crops (food legumes, tubers, oilseed crops, sugar crops, cotton, fodder, etc.), with associated livestock raised permanently on farms in an intensive way and/or livestock partly raised in surrounding marginal lands. In Saudi Arabia, irrigated cropping systems give large emphasis to cereal (wheat) production.

In small and medium-size countries which rely mainly on rainfed agriculture (Algeria, Eritrea, Ethiopia, Lebanon, Morocco, Tunisia) and in small countries relying largely on irrigation (Jordan and the small oil-exporting countries of the Arabian Peninsula), irrigated lands are mainly used for vegetables, fruits, date palm, fodder, and ornamentals. In the countries relying largely on irrigation, animal production (modern poultry husbandry, traditional small ruminants) is often a relatively important and separate activity.

In irrigated areas, productivity of land and labor is generally rather high, owing especially to the use of high-yielding varieties and industrial inputs (fertilizers, pesticides). The potential for productivity increases is still considerable through better management of irrigation structures and water use, and higher cropping intensity. Nevertheless, in many countries, excessive irrigation has led to the depletion of aquifers and the salinization of irrigated areas; water and wind erosion has induced loss of agricultural land and sedimentation of dams and reservoirs; and the competition in water use with other sectors is more and more acute. These problems of sustainability of natural resources (see below) are all the more urgent since prospects for increasing irrigated areas are very limited and expensive in most of the countries.

<sup>1</sup> The rate of agricultural self-sufficiency in Eritrea as estimated in Table 4 (7%) seems exaggeratedly low (probably due to unreliable statistics); however, according to FAO and IFAD, Eritrea was dependent on food aid for 75% of its food in 1993/94.

<sup>2</sup> During this period, the food diet decreased from 3,290 to 3,130 calories in Libya (reduced consumption of vegetables, fruit, meat, milk), from 2,310 to 2,250 calories in Iraq (mainly lower consumption of cereals and milk), and from 2,780 to 2,680 calories in Jordan (much lower consumption of milk). In the three countries, the reduction of milk consumption must certainly have had the strongest effect on children and the aged.

<sup>3</sup> Exceptions are the desert countries (especially in the Arabian Peninsula), Eritrea, Ethiopia, Sudan, and Yemen, which have summer rainfall.

<sup>4</sup> Estimate based on the fact that agricultural output of irrigated land is, on average, almost five times higher than that of rainfed land (Janssen, 1993).

The more favorable rainfed areas are estimated to provide around 40% of the agricultural production of the WANA region. Farming systems generally include wheat as the principal crop, with few other crops (food legumes, oilseeds, fodder) associated with relatively extensive small ruminant production. The potential for higher and sustainable productivity in these areas is large (but less than in irrigated areas), especially through wide replacement of fallow with food and feed legumes or oilseeds, more extensive use of supplementary irrigation, and higher integration of animal production and cropping systems. Susceptibility to degradation in these areas is less than in irrigated lands and marginal rainfed areas and rangelands.

Marginal rainfed areas and rangelands provide less than 10% of the agricultural production of the WANA region. Barley is the main crop. Small ruminants use rangelands and consume fodder and crop residues of the surrounding more favored areas. The potential for increasing crop and animal performance is rather low. These areas suffer from accelerated degradation owing to their still relatively high populations, their crop/livestock practices (degradation of rangelands subjected to intensive barley cropping and animal raising), and rapid changes in tenure systems. Pressure on these areas could be reduced mainly by developing the productive potential of irrigated and favored rainfed areas.

### Main Commodities

To date, there has been limited recent information related to the relative economic importance of agricultural commodities produced in the WANA region, whether through international organizations<sup>1</sup> or individual countries<sup>2</sup>. Based on the available data on physical production and international prices, it has been possible to design [Table 7](#) (see also [Tables 7a](#) to [7c](#) in Annex 2.1), which gives for the period 1991–1995 the relative values of the main commodities of the WANA countries<sup>3</sup>, and thus an approximate overview of the breakdown of the AGDP per main commodities and per country and for the entire WANA region<sup>4</sup>.

Cereals (mainly wheat, then barley, and lagging behind are sorghum, rice, maize, etc.) represent around 22% of the total value of the main commodities of the region. This percentage is higher in Ethiopia, Saudi Arabia, and Syria, but much lower in the smaller countries (8.2% in Libya and much less in Cyprus, Jordan, Lebanon, and the oil-exporting countries of the Arabian Peninsula).

Both vegetable and fruit production represent together almost 45% of the regional AGDP. Their relative high importance relies on the comparative advantage for countries with high labor-to-land ratio to undertake labor-intensive agriculture. In some countries, these commodities constitute the bulk of the agricultural added value (Iran: 50%; Iraq: 65%; Lebanon: 76%; Oman: 68%; United Arab Emirates: 74%). Eritrea, Ethiopia, and Sudan pay little attention to these crops because of their poor food diet and probably because of their traditional food habits.

Other crops (food legumes, roots, tubers, oil crops, fiber crops, sugar crops) are relatively marginal (around 13% of the AGDP), except in Eritrea and Ethiopia.

Animal production (meat and milk) is rather limited in the WANA region (around 20% of the regional AGDP), except in countries where pastoralism is still highly practiced (Eritrea and Sudan and, to a lesser extent, Algeria and Ethiopia), and in the small oil-exporting countries of the Arabian Peninsula which have developed “industrial” chicken production.

<sup>1</sup> FAO and Medagri (CIEHEAM, Allaya) yearbooks concentrate on production data and do not take into account their value. Grysse (1992) gives a brief view of the main groups of commodities, focusing on those having a value of production that is over US\$ 2 billion (wheat, barley, tomatoes, potatoes, oranges, grapes, milk, sheep and goat meat, beef). Rodriguez (1997) provides data on the annual value of agricultural production of “ICARDA commodities” (wheat, barley, food legumes) in the dry areas (including some non-WANA countries).

<sup>2</sup> In the WANA countries (as well as in most of the other developing countries), national statistics focus generally on production data (cultivated crop area, yield, production; animal numbers and production). Until present, it seems that no country has published agricultural national accounts, even in those countries which have recently designed strategic plans for agricultural research.

<sup>3</sup> The use of international prices instead of national prices (which are not easily available) has another advantage: comparisons between ADGP at national and international prices (see annex, Table 7b) may help to globally appreciate the relative level of national prices and to understand some “incoherencies” observed in the AGDP estimates for some countries. Examples of this are: despite significantly higher production than Algeria for almost all commodities, Morocco has a lower AGDP because of its much lower internal prices; the same is true between Iraq and Syria (larger physical production, lower AGDP); AGDP in Egypt, and much more so in Ethiopia, is underestimated when considering international prices.

<sup>4</sup> Other commodities than those considered in Table 7 are globally marginal; however, it is worth mentioning fish which is relatively important only in Morocco (600,000 tons, valued at around US\$ 560 million, i.e., a little more than 10% of the AGDP at national prices) and Oman (30% of its AGDP at national prices), and coffee grown mainly in Ethiopia (7% of its AGDP at national prices).

**Table 7 - The WANA Region: Relative Value of the Main Commodities (1991–1995)**  
% (rounded numbers) of the value of these main commodities

*Italics:* Approximate data. .... Data not available. –: Marginal commodities.  
Other crops: Food legumes, roots and tubers, oil crops, fiber crops, sugar crops.

Country/ Sub-Region	Cereals	Vege- tables	Fruits	Other Crops	Meat	Milk	Total
1 Algeria	14.7	28.2	15.7	11.8	23.2	6.9	100
2 Libya	8.2	35.6	17.8	6.9	27.4	4.1	100
3 Morocco	21.6	23.4	22.6	12.9	14.7	4.8	100
4 Tunisia	17.4	34.2	19	10.3	12.5	6.5	100
<b>A North Africa</b>	<b>17.9</b>	<b>27.6</b>	<b>19.6</b>	<b>11.5</b>	<b>17.8</b>	<b>5.6</b>	<b>100</b>
5 Egypt	23.2	28.9	18.8	13.6	10.7	4.8	100
6 Eritrea	20	6.7	...	33.3	33.3	6.7	100
7 Ethiopia	36.8	5.3	3.3	26.2	22.7	5.7	100
8 Sudan	22.7	9.8	10	14.8	19.5	23.2	100
<b>B Nile Valley/Red Sea</b>	<b>25.8</b>	<b>20.5</b>	<b>14</b>	<b>16.5</b>	<b>14.9</b>	<b>8.3</b>	<b>100</b>
9 Cyprus	6.7	11.1	33.3	13.3	26.7	8.9	100
10 Iraq	20.4	38.4	26.2	5.7	5.7	3.6	100
11 Jordan	2.7	45.9	20.3	4.1	21.6	5.4	100
12 Lebanon	1.6	28.4	47.2	9.7	9.8	3.3	100
13 Syria	26.5	18.7	18.9	17.6	9.7	8.6	100
<b>C West Asia</b>	<b>18.2</b>	<b>28</b>	<b>25.9</b>	<b>11.5</b>	<b>10.3</b>	<b>6.1</b>	<b>100</b>
14 Iran	21.3	21.6	28.1	11.3	11.8	5.9	100
15 Turkey	22.3	29	17	15.5	6.7	9.5	100
<b>D Highlands</b>	<b>21.9</b>	<b>26.3</b>	<b>21.1</b>	<b>14</b>	<b>8.5</b>	<b>8.2</b>	<b>100</b>
16 Bahrain	–	11.1	22.2		55.6	11.1	100
17 Kuwait	–	23.5	–		70.6	5.9	100
18 Oman	–	27.3	40.9	2.3	20.5	9.1	100
19 Qatar	–	27.3	9.1		54.5	9.1	100
20 Saudi Arabia	31	25.9	14.2	2.1	22.6	4.2	100
21 United Arab Emirates	–	45.7	28.3		23.9	2.2	100
22 Yemen	18.1	22.9	20.5	10.2	22.9	5.4	100
<b>E Arabian Peninsula</b>	<b>23.2</b>	<b>27.2</b>	<b>17.7</b>	<b>3.2</b>	<b>24.1</b>	<b>4.6</b>	<b>100</b>
<b>F Total WANA</b>	<b>22.1</b>	<b>25.3</b>	<b>19.5</b>	<b>13.4</b>	<b>12.2</b>	<b>7.5</b>	<b>100</b>

Source: See Annex 2.1, Tables 7a, 7b and 7c.

### **2.3.2 Limited Natural Resources: Major Constraints to Agricultural Development**

Agricultural development in the WANA region is constrained by many factors relating to farming systems and their physical and socioeconomic environment. Most of these factors, such as those in poorly endowed farms (limited natural resources, little capital, low education of farmers), and such as limited infrastructures (communication, marketing), not easily available inputs (seeds, fertilizers, etc.) and credit, lack of farmers' unions or organizations, inefficient extension and research services or centers (see Chapter 9), etc., exist also in other developing regions.

Nevertheless, in all the WANA region (except Sudan and Turkey), the major constraints specific to agriculture are the strong pressure imposed by the very limited natural resources: land and water<sup>1</sup>.

#### **Limited Land Resources (Table 8)**

In the WANA region, arable land represents only 7.5% of the total land resources, ranging from less than 2% in the Arabian Peninsula to 33 and 35% in Lebanon and Turkey, respectively. Arable land is very limited compared with the population; the region currently has an average of 0.25 ha of arable land per capita. Some countries such as Eritrea, Jordan, and most of the Arabian Peninsula countries are already in a particularly critical situation, with less than 0.1 ha of low-production-potential arable land per capita (semi-arid climate, poor irrigation potentiality). Egypt and Lebanon also have very limited arable land (0.08 and 0.11 ha per capita, respectively), but fully irrigated in the former and under a favorable climate in the latter.

In the long term, the situation will worsen with the fast growth of the population; arable land per capita will fall to only 0.15 ha, and all the WANA countries, except Sudan and Turkey (and, to a lesser extent, Iran), will face very high pressure on their arable lands.

Irrigated lands (currently 22% of the arable lands) will probably remain at the same level as the development of new schemes will certainly compensate for the loss or degradation of cultivated lands in the present schemes (see further).

Permanent pastures and rangelands, which cover around 30% of the total area of the WANA region and provide around one-third of the diet of livestock, are severely degraded by unrestricted grazing and climate deterioration.

All these land problems will be more acute with the continuous degradation of soils due to erosion (water runoff, wind erosion), loss of nutrients through inappropriate management, and salinization. The excessively growing land fragmentation (1.7 ha of arable land per agricultural laborer at present, against 2.4 in 1980, for all the region, and probably less than 0.6 ha in 2025) will also hinder productivity.

#### **Scarce Water Resources (Tables 9 and 10)**

Because of its climate, WANA is the region showing the lowest figures worldwide of water resources and uses in absolute terms and per capita, even considering the contribution of rivers flowing from more humid regions of tropical Africa (the Nile River) or from Turkey.

The distribution of renewable water resources (RWR) is very heterogeneous among the countries (and within each country), with contrasted situations according to land relief, location from the sea, latitude and resulting hydro-climatic conditions, hydrographic networks and geological structures, and trans-boundary rivers. Twelve countries (Algeria, Cyprus, Jordan, Libya, Tunisia, and all the Arabian Peninsula countries) suffer severe water scarcity with a total (internal and external) RWR below the absolute "poverty threshold" of 500 m<sup>3</sup>/capita/year. The situation is slightly better in Egypt because of its external RWR. The other countries enjoy a more or less favorable situation (total RWR exceeding 1000 m<sup>3</sup>/capita/year); among these Eritrea, Iraq, and Syria are highly dependent on external RWR through trans-boundary rivers, with increasing tensions between neighboring countries over the use of international rivers and aquifers.

Renewable water resources are currently widely exploited. In all countries there has been an intensification of water development and withdrawals through building of dams/reservoirs and capturing or pumping renewable or fossil groundwater. The annual quantity of water used varies from country to country, from hardly 150 m<sup>3</sup>/capita/year (Algeria, Jordan) to more than 1,100 m<sup>3</sup>/capita/year (Egypt, Libya). The exploitation index (annual withdrawals to annual average RWR, expressed as a percentage) already exceeds 50% in some countries (Egypt, Syria, Tunisia), or even 100% in Jordan (in which wastewater reuse has rapidly increased) and Libya (where over 90% of the water demand is covered by exploitation of fossil water).

<sup>1</sup> The following presentation on land and water resources in the WANA region is based on several references, especially the 1997 FAO report on *Irrigation in the Near East Region* (in fact, in the WANA region); Hamdy and Lacingnola (1998); and Furtado, Schoonhoven, and El-Deen (ICARDA, 1992).

**Table 8 - The WANA Region: Land Resources**
*Italics: Approximate data. ... Data not available.*

Country/ Sub-Region	Land Resources (1996) (million ha)				Population (TP)			Arable Area per Capita (AA/TP in ha)			Agric. Labor Force (ALF)		Arable Area per Ag. Lab. (AA/ALF ha)	
	Total	Arable (AA)	Irrig.	Perm. Pastur.	1980	2000	2025	1980	2000	2025	1980	1996	1980	1996
1 Algeria	238	8.0	0.56	32	18.7	33.4	52	0.43	0.24	0.15	1.35	2.3	5.9	3.5
2 Libya	176	2.1	0.47	13	3.1	6.4	13	0.68	0.33	0.16	0.14	0.12	15	18
3 Morocco	70	9.7	1.26	21	19.4	31.8	48	0.50	0.30	0.20	2.6	4.1	3.7	2.4
4 Tunisia	16	4.9	0.39	3	6.4	10.2	13	0.77	0.48	0.38	0.7	0.9	7	5.4
<b>A North Africa</b>	<b>500</b>	<b>24.7</b>	<b>2.7</b>	<b>69</b>	<b>47.6</b>	<b>81.8</b>	<b>126</b>	<b>0.52</b>	<b>0.30</b>	<b>0.20</b>	<b>4.8</b>	<b>7.4</b>	<b>5.1</b>	<b>3.3</b>
5 Egypt	100	3.3	3.3	0	40.9	66	94	0.08	0.05	0.04	5.1	8.4	0.65	0.4
6 Eritrea	12	0.5	0.03	...	38.7	3.8	10	0.37	0.13	0.05	14.1	1.3	1	0.4
7 Ethiopia	122	14	0.19	20	66	125	...	0.21	0.11	...	21.8	...	...	0.6
8 Sudan	250	13	1.95	110	18.7	33	61	0.70	0.39	0.21	4.3	6.8	3	1.9
<b>B Nile Val/Red Sea</b>	<b>484</b>	<b>30.8</b>	<b>5.5</b>	<b>130</b>	<b>98.3</b>	<b>168.3</b>	<b>280</b>	<b>0.31</b>	<b>0.18</b>	<b>0.11</b>	<b>24.7</b>	<b>38.5</b>	<b>1.2</b>	<b>0.8</b>
9 Cyprus	0.9	0.14	0.04	...	0.61	0.8	0.9	0.23	0.18	0.16	0.16	0.04	0.9	3.5
10 Iraq	43	5.8	3.5	4	13.0	26.2	46	0.45	0.22	0.13	1.1	0.7	5.3	8.3
11 Jordan	8.9	0.4	0.08	0.8	2.9	6	11	0.14	0.07	0.04	0.7	0.16	0.6	2.5
12 Lebanon	1.0	0.3	0.1	0	2.7	3.3	4.5	0.11	0.09	0.07	0.1	0.05	3	6
13 Syria	18.5	5.2	1.1	9.3	8.7	17.9	35	0.60	0.29	0.15	0.8	1.3	6.5	4
<b>C West Asia</b>	<b>72.3</b>	<b>11.8</b>	<b>4.8</b>	<b>14</b>	<b>27.9</b>	<b>54.2</b>	<b>97</b>	<b>0.42</b>	<b>0.22</b>	<b>0.12</b>	<b>2.9</b>	<b>2.3</b>	<b>4.1</b>	<b>5.4</b>
14 Iran	163	19.4	7.3	...	37.2	66.7	100	0.49	0.29	0.19	4	6	4.9	3.2
15 Turkey	77	26.9	4.2	12	44.5	65.8	91	0.60	0.41	0.30	11	14	2.4	1.9
<b>D Highlands</b>	<b>240</b>	<b>46.3</b>	<b>11.5</b>	<b>...</b>	<b>81.7</b>	<b>122.5</b>	<b>191</b>	<b>0.55</b>	<b>0.38</b>	<b>0.24</b>	<b>15</b>	<b>20</b>	<b>3.1</b>	<b>2.3</b>
16 Bahrain	0.07	0.004	0.003	0.004	0.29	0.64	1.0	0.1	0.06	0.04	...	0.004	...	1
17 Kuwait	1.8	0.005	0.004	0.1	1.37	2.7	2.8	0.003	0.01	0.01	...	0.007	...	0.7
18 Oman	21	0.06	0.06	1	0.99	2.3	4.7	0.06	0.03	0.01	0.14	0.25	0.42	0.24
19 Qatar	1	0.02	0.01	0.05	0.21	0.6	0.7	0.1	0.03	0.02	...	0.006	...	3.3
20 Saudi Arabia	215	3.8	1.5	120	9.4	20.1	40	0.40	0.19	0.10	1.3	0.8	2.9	4.8
21 UA Emirates	8	0.07	0.07	0.2	0.75	2.0	2.8	0.09	0.04	0.03	...	0.07	...	1
22 Yemen	53	1.5	0.49	16	8.2	16.4	43	0.18	0.09	0.03	1.2	2.7	1.3	0.7
<b>E Arabian Peninsula</b>	<b>299.9</b>	<b>5.4</b>	<b>2.1</b>	<b>120</b>	<b>21.2</b>	<b>44.7</b>	<b>95</b>	<b>0.25</b>	<b>0.12</b>	<b>0.06</b>	<b>2.7</b>	<b>3.8</b>	<b>2</b>	<b>1.4</b>
<b>F Total WANA</b>	<b>1596</b>	<b>119</b>	<b>26.6</b>	<b>...</b>	<b>277</b>	<b>472</b>	<b>789</b>	<b>0.43</b>	<b>0.25</b>	<b>0.15</b>	<b>5.4</b>	<b>3</b>	<b>2.4</b>	<b>1.7</b>

Source: FAO Production Yearbook (1997).

Note: In Sudan, the "potential arable land" is estimated at 74 million ha (most of it currently included in permanent pastures) (data from: El Taher F.H., Hamdoun A.M. - *The Role of Universities in the National Agricultural Research Systems of Egypt, Jordan, Morocco, the Sudan and Tunisia. Case Study no. 4: The Sudan* - Rome, FAO, Research and Technology Development Service, 1996, pp. 67-83).

**Table 9 - The WANA Region: Renewable Water Resources (RWR)**
*Italics:* Approximate data. .... Data not available. °: Rounded numbers. 0-∞: Minimal (almost zero).

Country/ Sub-Region	Total RWR (km <sup>3</sup> )				Fossil WR (km <sup>3</sup> )	Population (million)			RWR per Capita (m <sup>3</sup> /year)		
	Internal RWR a	External RWR b	Total RWR c = a + b	Depen- dency ratio b/c		1980	2000	2025	1980	2000	2025
1 Algeria	13.9	0.4	14.3	2.8	6.7	18.7	33.4	52	760	430	280
2 Libya	0.6	0	0.6	0	4.3	3.1	6.4	13	190	90	50
3 Morocco	30	0	30	0	10	19.4	31.8	48	1550	940	630
4 Tunisia	3.5	0.6	4.1	15	1.7	6.4	10.2	13	640	400	310
<b>A North Africa</b>	<b>48</b>	<b>1</b>	<b>49</b>	<b>2</b>	<b>22.7</b>	<b>47.6</b>	<b>81.8</b>	<b>126</b>	<b>1030</b>	<b>600</b>	<b>390</b>
5 Egypt	1.8	55.5	57.3	97	3.4	40.9	66	94	1400	870	610
6 Eritrea	2.8	6	8.8	68	...	38.7	3.8	10	3070	2320	880
7 Ethiopia	110	0	110	0	...	...	66	125	1670	880	...
8 Sudan	35	53.5	88.5	77	1.3	18.7	33	61	4730	2700	1460
<b>B Nile Val./Red Sea</b>	<b>149.6</b>	<b>115</b>	<b>264.6</b>	<b>43</b>	<b>...</b>	<b>98.3</b>	<b>168.3</b>	<b>280</b>	<b>2690</b>	<b>1570</b>	<b>950</b>
9 Cyprus	0.9	0	0.9	0	...	0.61	0.8	0.9	150	110	100
10 Iraq	35.2	40.2	75.4	53	2	13.0	26.2	46	5800	2880	1630
11 Jordan	0.7	0.2	0.9	23	0.3	2.9	6	11	310	150	80
12 Lebanon	4.8	0	4.8	0	3	2.7	3.3	4.5	1780	1460	1070
13 Syria	7	19.2	26.2	80	5.6	8.7	17.9	35	3010	1220	740
<b>C West Asia</b>	<b>48.6</b>	<b>59.6</b>	<b>108.2</b>	<b>55</b>	<b>...</b>	<b>27.9</b>	<b>54.2</b>	<b>97</b>	<b>3880</b>	<b>2000</b>	<b>1120</b>
14 Iran	129	9	138	7	...	37.2	66.7	100	3710	2070	1380
15 Turkey	196	-12	184	0	...	44.5	65.8	91	4130	2800	2020
<b>D Highlands</b>	<b>325</b>	<b>-3</b>	<b>322</b>	<b>0</b>	<b>...</b>	<b>81.7</b>	<b>122.5</b>	<b>191</b>	<b>3940</b>	<b>2630</b>	<b>1690</b>
16 Bahrain	0.004	0.1	0.1	97	0.01	0.29	0.64	1.0	340	160	100
17 Kuwait	0	0.02	0.02	100	0.16	1.37	2.7	2.8	150	75	70
18 Oman	1	0	1	0	1	0.99	2.3	4.7	1010	430	210
19 Qatar	0.05	0	0.05	4	0.06	0.21	0.6	0.7	240	85	70
20 Saudi Arabia	2.4	0	2.4	0	0.02	9.4	20.1	40	260	120	60
21 UA Emirates	0.15	0	0.15	0	0.1	0.75	2.0	2.8	200	75	55
22 Yemen	4.1	0	4.1	0	1.4	8.2	16.4	43	500	250	95
<b>E Arab. Peninsula</b>	<b>7.7</b>	<b>0.1</b>	<b>7.8</b>	<b>1</b>	<b>2.8</b>	<b>21.2</b>	<b>44.7</b>	<b>95</b>	<b>370</b>	<b>175</b>	<b>80</b>
<b>F Total WANA°</b>	<b>579</b>	<b>173</b>	<b>2752</b>	<b>6</b>	<b>...</b>	<b>277</b>	<b>472</b>	<b>789</b>	<b>990</b>	<b>580</b>	<b>350</b>

a. Internal RWR: Average annual flows of rivers and recharge of groundwater generated from indigenous precipitation = internal surface water + internal groundwater – overlap (part of the WR which is common to both surface water and groundwater). b. External RWR: Actual external RWR = actual external surface water + actual external groundwater.

Source: FAO Water Reports (1997) for the Near East Region and for Africa. Population: FAO and World Population Prospects, UN (1995).



**Table 10 - The WANA Region: Annual Water Withdrawals (AWW)**
*Italics: Approximate data. °: Rounded numbers.*

Country/ Sub-Region Year of reference	AWW					AWW as % of	
	Agricultural km <sup>3</sup> - %	Domestic km <sup>3</sup>	Industrial km <sup>3</sup>	Total km <sup>3</sup>	m <sup>3</sup> per capita*	Internal RWR*	Total RWR*
1 Algeria 1990	2.7 60	1.1	0.7	4.5	160	30	30
2 Libya 1994	4 87	0.5	0.1	4.6	820	770	770
3 Morocco 1991	10.2 92	0.5	0.3	11	410	40	40
4 Tunisia 1990	2.7 89	0.3	0.1	3.1	340	90	75
<b>A North Africa</b>	<b>19.6 84</b>	<b>2.4</b>	<b>1.2</b>	<b>23.2</b>	<b>330</b>	<b>48</b>	<b>47</b>
5 Egypt 1993	47.4 86	3.1	4.6	55.1	910	3080	95
6 Eritrea 1987	1.9 86	0.2	0.1	2.2	35	2	2
7 Ethiopia							
8 Sudan 1995	16.8 94	0.8	0.2	17.8	650	50	20
<b>B Nile Valley/Red Sea</b>	<b>66.1 88</b>	<b>4.1</b>	<b>4.9</b>	<b>75.1</b>	<b>490</b>	<b>50</b>	<b>28</b>
9 Cyprus 1993	0.16 74	0.05	0.005	0.2	260	23	23
10 Iraq 1990	39.4 92	1.3	2.1	42.8	2080	120	60
11 Jordan 1993	0.8 75	0.2	0.03	1°	230	145	110
12 Lebanon 1994	0.9 68	0.4	0.05	1.3	420	30	30
13 Syria 1993	13.6 94	0.5	0.3	14.4	990	210	55
<b>C West Asia</b>	<b>54.8° 93</b>	<b>2.5°</b>	<b>2.4°</b>	<b>59.7</b>	<b>1370</b>	<b>120</b>	<b>55</b>
14 Iran 1993	64.1 92	4.4	1.5	70	1090	55	50
15 Turkey 1992	22.9 72	5.2	3.5	31.6	510	15	20
<b>D Highlands</b>	<b>87 86</b>	<b>9.6</b>	<b>5</b>	<b>101.6</b>	<b>770</b>	<b>31</b>	<b>32</b>
16 Bahrain 1991	0.13 56	0.01	0.001	0.2	350	5980	210
17 Kuwait 1994	0.3 60	0.2	0.01	0.5	290	0	2690
18 Oman 1991	1.1 94	0.06	0.02	1.2	520	120	120
19 Qatar 1994	0.2 74	0.07	0.01	0.3	540	560	540
20 Saudi Arabia 1992	15.3 90	1.5	0.2	17	900	710	710
21 UA Emirates 1995	1.4 67	0.5	0.2	2.1	930	1410	1410
22 Yemen 1990	2.7 92	0.2	0.03	2.9	180	70	70
<b>E Arabian Peninsula</b>	<b>21.1 87</b>	<b>2.6</b>	<b>0.5°</b>	<b>24.2</b>	<b>580</b>	<b>314</b>	<b>310</b>
<b>F Total WANA°</b>	<b>248.6 88</b>	<b>21.2</b>	<b>14</b>	<b>283.8</b>	<b>650</b>	<b>49</b>	<b>10</b>

\*: AWW per capita refers (for more convenience) to the populations in 1993 for all the countries (actual figures referring to previous years and to lower populations are generally slightly higher). RWR: Renewable Water Resources (see Table 9).

Source: FAO Water Reports (1997) for the Near East Region and for Africa.

Waste in water use is generally very important in quantity and quality. Many countries have poor water-use efficiency. Agriculture, which is by far the most important water user (around 80% of the water withdrawals in the WANA region), is probably the least efficient sector, with water losses of more than 60% in irrigation originating from physical and economic mismanagement (poor maintenance/performance of the irrigation/drainage systems, poor distribution and on-farm application, water prices much below the real costs, private open access to aquifers, etc.). In the urban/domestic withdrawals, which now absorb only 15% of the total water withdrawals, losses may also be important for similar reasons. Water degradation and pollution (pathogen and organic matter, nitrates, salt, heavy metals, etc.) originating from agricultural, domestic, and industrial activities have been increasing over the years.

Over the next decades, an imbalance between the constantly increasing demand for water and RWR will affect most of the WANA region, and the situation will worsen in the long term with:

- the steady increase in water withdrawals originating from the total population growth (see Table 9), the explosive urban and industrial growth, and, in some countries (Egypt, Jordan, Morocco, Tunisia), the extensive development of tourism;
- the higher unit costs of actual water availability in the future as all the easily available sources of water (rivers, dams and reservoirs, underground water) have been developed or are in the process of development, and as refining of polluted/contaminated water and use of non-conventional sources of water (desalination, wastewater reuse) are very expensive; thus, the cost per cubic meter of domestic water for the next generation will dramatically increase in the region (two- to threefold the cost for the present generation according to the World Bank, 1994).

In any case, sustainable management of water resources is vital for the future. It is now largely acknowledged that managing water, as a rare economic commodity, is an essential way for achieving its efficient and equitable use and encouraging its conservation and protection. Water use for agriculture will be under strong pressure as it will be more and more affected by the increasing competition and conflict among alternative uses, particularly domestic, urban and tourist consumption.

## 2.4 CONCLUSION: THE CHALLENGING ROLE OF AGRICULTURAL RESEARCH

In the coming decades, agricultural development in the WANA region should provide food and employment for the inevitably increasing population. However, this task will be impossible to fully achieve, and a realistic challenge would be to improve, or at least preserve, the current rate of agricultural self-sufficiency.

Being able to face this challenge will depend on further intensification of farming systems and resource use: cropping frequency (through fallow replacement) should be increased; marginal land may be made more productive; and animal performance should be improved. Intensification may be aimed at without jeopardizing the sustainability of agriculture as in the past decades; all gains should be obtained through improving land and water use. Promoting competitive and sustainable agricultural and food sectors will not be sufficient; social equity should be also considered, especially through development of small farms and marginal rainfed and rangeland areas.

Such prospects will not be possible without appropriate agricultural and economic policies which would help to improve input/credit delivery, marketing of agricultural output, and institutional changes (agrarian reform). Agricultural research (AR) would be a major component of such policies in order to provide technological alternatives that would simultaneously allow for intensified and sustainable production and stabilized or increased agricultural labor.

As in the past, AR should contemplate crop and animal improvement and natural resource management through traditional specialized or separate approaches (genetics, agronomy and nutrition, integrated pest management, etc.). However, integrated research on cereals, other crops, and animal production should receive higher attention and even the first priority as it is now well known that farming systems, with higher integration of crop and animal production, are essential for long-term productivity and sustainability of each commodity and the whole farming systems<sup>1</sup>. Instead of looking for specialized technological innovations, research should propose models of more efficient and sustainable farming systems adapted to each dominant type of farming, taking into account: (i) their agroecological conditions; and (ii) their current characteristics as well as their possibilities for future evolution which may depend on possible changes in their socioeconomic environments. Such approach necessitates that AR in each country develops and extends research on farming systems that aims to: (i) design national typologies of farms, (ii) analyze the constraints affecting each dominant type of farms and the reasons for the limited adoption of available research results, and (iii) elaborate and test models of sustainable intensification in close collaboration with specialized researchers (biologists and rural socioeconomicists). This task should be the responsibility of permanent

<sup>1</sup> On this issue, see research done by ICARDA (at Aleppo and within some of its collaborative programs), INRA/Morocco, INRAT/Tunisia, etc.

multidisciplinary teams<sup>1</sup> which would undertake applied and action-oriented research at the farm level with farmers and extension agents, as well as sophisticated research (including the use of mathematical models) and long-term research in research stations.

All these issues related with AR will be further discussed in Chapter 9, Section 9.4.1.

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<sup>1</sup> Those teams should include one or several researchers on cropping systems, livestock systems, and natural resource management, and agroeconomists specialized in farm socioeconomics and modeling. On the precise role of these farming systems teams, see FAO (Casas and Beye, 1998).

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<sup>1</sup> Scientific Editor's note: This publication, as well as the previous one, refers not only to the Near East but also to the Middle East and North Africa region

# Annex 2.1 - Tables Related to the Economic Importance of the Main Agricultural Commodities in the WANA Region

**Table 7a - The WANA Region: Annual Production of Main Agricultural Commodities (1991–1995)**  
1000 tons (rounded numbers).

*Italics:* Approximate data. –: Less than 10,000 tons (less than 5,000 tons for countries 16, 17, 18, 19 and 21). ....: Data not available.

Country/ Sub-Region	Cereals	Vege- tables	Fruits	Other crops					Meat	Milk	Fish*
				Food legumes	Roots & tubers	Oil crops	Fiber crops	Sugar			
1 Algeria	2340	2320	1060	50	1040	70	–	–	480	900	80
2 Libya	310	670	270	10	140	20	–	–	130	130	10
3 Morocco	5180	2890	2310	230	950	170	–	480	460	950	600
4 Tunisia	1590	1610	740	80	220	180	–	20	150	520	90
<b>A North Africa</b>	<b>9420</b>	<b>7490</b>	<b>4380</b>	<b>370</b>	<b>2350</b>	<b>440</b>	<b>10</b>	<b>500</b>	<b>1220</b>	<b>2500</b>	<b>780</b>
5 Egypt	14930	9510	5130	480	2040	180	330	1130	890	2590	300
6 Eritrea	170	30	...	40	110	...	...	...	30	40	...
7 Ethiopia	7700	570	300	850	2080	150	...	140	610	1010	...
8 Sudan	4320	950	800	110	160	340	90	480	480	3660	30
<b>B Nile Val./Red Sea</b>	<b>27120</b>	<b>11060</b>	<b>6230</b>	<b>1480</b>	<b>4390</b>	<b>670</b>	<b>420</b>	<b>1750</b>	<b>2010</b>	<b>7300</b>	<b>330</b>
9 Cyprus	150	130	320	–	190	–	–	–	80	160	–
10 Iraq	2850	2750	1560	40	330	40	10	–	100	400	10
11 Jordan	120	870	320	10	80	10	–	–	100	150	–
12 Lebanon	80	910	1240	40	290	20	–	20	80	180	–
13 Syria	4900	1780	1480	190	410	190	210	100	230	1320	10
<b>C West Asia</b>	<b>8100</b>	<b>6440</b>	<b>4920</b>	<b>280</b>	<b>1300</b>	<b>260</b>	<b>220</b>	<b>120</b>	<b>590</b>	<b>2210</b>	<b>20</b>
14 Iran	16140	8370	9050	610	2870	190	150	900	1150	3730	260
15 Turkey	29440	19670	9570	1850	4590	730	650	1900	1140	10420	370
<b>D Highlands</b>	<b>45580</b>	<b>28040</b>	<b>18620</b>	<b>2460</b>	<b>7460</b>	<b>920</b>	<b>800</b>	<b>2800</b>	<b>2290</b>	<b>14150</b>	<b>630</b>
16 Bahrain	–	10	25	–	–	–	–	–	15	20	...
17 Kuwait	–	55	–	–	–	–	–	–	40	20	–
18 Oman	5	160	200	–	10	–	–	–	25	80	120
19 Qatar	5	40	10	–	–	–	–	–	20	25	...
20 Saudi Arabia	4810	2050	940	10	200	–	–	–	450	540	50
21 UA Emirates	10	530	280	–	–	–	–	–	70	50	...
22 Yemen	740	490	360	70	180	10	–	–	120	190	90
<b>E Arab. Peninsula</b>	<b>5570</b>	<b>3335</b>	<b>1815</b>	<b>80</b>	<b>390</b>	<b>10</b>	<b>0</b>	<b>0</b>	<b>740</b>	<b>925</b>	<b>260</b>
<b>F Total WANA</b>	<b>95790</b>	<b>56365</b>	<b>35966</b>	<b>4670</b>	<b>15890</b>	<b>2300</b>	<b>1450</b>	<b>5170</b>	<b>6850</b>	<b>27085</b>	<b>2020</b>

Source: FAO Production Yearbooks and Country Tables; Medagri 1999 (CIHEAM, Allaya).

Fish: Data for 1991.

**Table 7b - The WANA Region: Annual Value of the Main Agricultural Commodities (1991–1995)**  
 Million US\$ (rounded numbers)

*Italics:* Approximate data. .... Data not available. –: Less than US\$ 10 million (except for countries 16, 17, 18, 19 and 21).

Country/ Sub-Region	Cereals	Vege- tables	Fruits	Other crops					Meat	Milk	Total	AGDP
				Food legumes	Roots & tubers	Oil crops	Fiber crops	Sugar				
1 Algeria	470	900	500	20	300	40	–	–	740	220	3190	5400
2 Libya	60	260	130	–	40	10	–	–	200	30	730	2000
3 Morocco	1040	1130	1090	100	280	90	–	150	710	230	4820	5300
4 Tunisia	320	630	350	30	60	90	–	10	230	120	1840	2400
<b>A North Africa</b>	<b>1890</b>	<b>2920</b>	<b>2070</b>	<b>150</b>	<b>680</b>	<b>230</b>	<b>–</b>	<b>160</b>	<b>1880</b>	<b>600</b>	<b>10580</b>	<b>15100</b>
5 Egypt	2990	3710	2410	210	590	100	490	360	1380	620	13860	12100
6 Eritrea	30	10	...	20	30	...	...	...	...	...	90	110
7 Ethiopia	1540	220	140	370	600	80	–	40	950	240	4180	3400
8 Sudan	860	370	380	50	50	180	130	150	740	880	3790	3100
<b>B Nile V./Red Sea</b>	<b>5420</b>	<b>4310</b>	<b>2930</b>	<b>650</b>	<b>1270</b>	<b>360</b>	<b>620</b>	<b>550</b>	<b>3070</b>	<b>1740</b>	<b>20920</b>	<b>18500</b>
9 Cyprus	30	50	150	–	60	–	–	–	120	40	450	1000
10 Iraq	570	1070	730	20	100	20	20	–	160	100	2790	7900
11 Jordan	20	340	150	–	20	10	–	–	160	40	740	600
12 Lebanon	20	350	580	20	80	10	–	10	120	40	1230	1600
13 Syria	980	690	700	80	120	100	320	30	360	320	3700	4900
<b>C West Asia</b>	<b>1620</b>	<b>2500</b>	<b>2310</b>	<b>120</b>	<b>380</b>	<b>140</b>	<b>340</b>	<b>40</b>	<b>920</b>	<b>540</b>	<b>8910</b>	<b>16000</b>
14 Iran	3230	3260	4250	260	830	100	230	290	1780	900	15130	20000
15 Turkey	5890	7670	4500	800	1330	390	980	610	1770	2500	26440	28000
<b>D Highlands</b>	<b>9120</b>	<b>10930</b>	<b>8750</b>	<b>1060</b>	<b>2160</b>	<b>490</b>	<b>1210</b>	<b>900</b>	<b>3550</b>	<b>3400</b>	<b>41570</b>	<b>48900</b>
16 Bahrain	–	5	10	–	–	–	–	–	15	5	30	50
17 Kuwait	–	20	–	–	–	–	–	–	60	5	85	400
18 Oman	–	60	90	–	5	–	–	–	45	20	220	400
19 Qatar	–	15	5	–	–	–	–	–	30	5	55	70
20 Saudi Arabia	960	800	440	5	60	–	–	–	700	130	3095	9700
21 UA Emirates	–	210	130	–	–	–	–	–	110	10	460	700
22 Yemen	150	190	170	30	50	5	–	–	190	45	830	900
<b>E Arab. Peninsula</b>	<b>1110</b>	<b>1300</b>	<b>845</b>	<b>35</b>	<b>115</b>	<b>5</b>	<b>0</b>	<b>0</b>	<b>1150</b>	<b>220</b>	<b>4780</b>	<b>12200</b>
<b>F Total WANA</b>	<b>19160</b>	<b>21960</b>	<b>16905</b>	<b>2015</b>	<b>4605</b>	<b>1225</b>	<b>2170</b>	<b>1650</b>	<b>10570</b>	<b>6500</b>	<b>86760</b>	<b>110000</b>

Source: Values estimated from production (Table 7a) and average international prices calculated from 1993 FAO Production Yearbook (years 1991–1993) and from figures (prices for 1992–1994) presented by Mona (1997): US\$/ton 200 for cereals, 430 for food legumes, 290 for roots and tubers (mainly potatoes), 540 for oil crops, 390 for vegetables, 470 for fruits, 150 for fiber crops (cotton), 320 for sugar, 155 for meat, and 24 for milk.

Note: Other main commodities for some countries:

- Fishing is an important activity only in Morocco (600,000 tons, valued at around US\$ 560 million, i.e. a little more than 10% of the AGDP at national prices) and Oman (30% of its AGDP at national prices).
- Coffee is grown mainly in Ethiopia (in 1991–1995: annual production was 180,000 tons, worth around US\$ 240 million: 7% of its AGDP at national prices).

**Table 7c - The WANA Region: Relative Value of the Main Agricultural Commodities (1991–1995)**  
 % (rounded numbers) of the total value of these main commodities

*Italics:* Approximate data. ...: Data not available. -: Marginal commodities.

Country/ Sub-Region	Cereals	Vege- tables	Fruits	Other crops					Meat	Milk	Total
				Food legumes	Roots & tubers	Oil crops	Fiber crops	Sugar			
1 Algeria	14.7	28.2	15.7	0.6	9.4	1.3	–	–	23.2	6.9	100
2 Libya	8.2	35.6	17.8	–	5.5	1.4	–	–	27.4	4.1	100
3 Morocco	21.6	23.4	22.6	2.1	5.8	1.9	–	3.1	14.7	4.8	100
4 Tunisia	17.4	34.2	19	1.6	3.3	4.9	–	0.5	12.5	6.5	100
<b>A North Africa</b>	<b>17.9</b>	<b>27.6</b>	<b>19.6</b>	<b>1.4</b>	<b>6.4</b>	<b>2.2</b>	<b>–</b>	<b>1.5</b>	<b>17.8</b>	<b>5.6</b>	<b>100</b>
5 Egypt	23.2	28.9	18.8	1.6	4.6	0.8	3.8	2.8	10.7	4.8	100
6 Eritrea	20	6.7	...	13.3	20	...	...	...	33.3	6.7	100
7 Ethiopia	36.8	5.3	3.3	8.9	14.4	1.9	...	1.0	22.7	5.7	100
8 Sudan	22.7	9.8	10	1.3	1.3	4.7	3.4	4.0	19.5	23.2	100
<b>B Nile Val/Red Sea</b>	<b>25.8</b>	<b>20.5</b>	<b>14</b>	<b>3.1</b>	<b>6.1</b>	<b>1.7</b>	<b>3.0</b>	<b>2.6</b>	<b>14.9</b>	<b>8.3</b>	<b>100</b>
9 Cyprus	6.7	11.1	33.3	–	13.3	–	–	–	26.7	8.9	100
10 Iraq	20.4	38.4	26.2	0.7	3.6	0.7	0.7	–	5.7	3.6	100
11 Jordan	2.7	45.9	20.3	–	2.7	1.4	–	–	21.6	5.4	100
12 Lebanon	1.6	28.4	47.2	1.6	6.5	0.8	–	0.8	9.8	3.3	100
13 Syria	26.5	18.7	18.9	2.2	3.2	2.7	8.7	0.8	9.7	8.6	100
<b>C West Asia</b>	<b>18.2</b>	<b>28</b>	<b>25.9</b>	<b>1.4</b>	<b>4.3</b>	<b>1.6</b>	<b>3.8</b>	<b>0.4</b>	<b>10.3</b>	<b>6.1</b>	<b>100</b>
14 Iran	21.3	21.6	28.1	1.7	5.5	0.7	1.5	1.9	11.8	5.9	100
15 Turkey	22.3	29	17	3.0	5.0	1.5	3.7	2.3	6.7	9.5	100
<b>D Highlands</b>	<b>21.9</b>	<b>26.3</b>	<b>21.1</b>	<b>2.5</b>	<b>5.2</b>	<b>1.2</b>	<b>2.9</b>	<b>2.2</b>	<b>8.5</b>	<b>8.2</b>	<b>100</b>
16 Bahrain	–	11.1	22.2	–	–	–	–	–	55.6	11.1	100
17 Kuwait	–	23.5	–	–	–	–	–	–	70.6	5.9	100
18 Oman	–	27.3	40.9	–	2.3	–	–	–	20.5	9.1	100
19 Qatar	–	27.3	9.1	–	–	–	–	–	54.5	9.1	100
20 Saudi Arabia	31	25.9	14.2	0.2	1.9	–	–	–	22.6	4.2	100
21 U A Emirates	–	45.7	28.3	–	–	–	–	–	23.9	2.2	100
22 Yemen	18.1	22.9	20.5	3.6	6.0	0.6	–	–	22.9	5.4	100
<b>E Arab. Peninsula</b>	<b>23.2</b>	<b>27.2</b>	<b>17.7</b>	<b>0.7</b>	<b>2.4</b>	<b>0.1</b>	<b>0</b>	<b>0</b>	<b>24.1</b>	<b>4.6</b>	<b>100</b>
<b>F Total WANA</b>	<b>22.1</b>	<b>25.3</b>	<b>19.5</b>	<b>2.3</b>	<b>5.3</b>	<b>1.4</b>	<b>2.5</b>	<b>1.9</b>	<b>12.2</b>	<b>7.5</b>	<b>100</b>

Source: Table 7b.

### **3. METHODOLOGY USED IN PREPARING THE MONOGRAPHS<sup>1</sup>**

#### **3.1 CONTENTS OF THE MONOGRAPHS**

#### **3.2 CONCEPTS/DEFINITIONS RELATED WITH NARS STRUCTURE**

3.2.1 Definition of the Public NARS

3.2.2 Categories of National Institutions Making up the NARS

#### **3.3 CONCEPTS/DEFINITIONS RELATED WITH NARS HUMAN AND FINANCIAL RESOURCES**

3.3.1 NARS Human Resources

3.3.2 NARS Financial Resources/Expenditures

3.3.3 Drawbacks and Advantages of the Method Used in Calculating the NARS Resources

#### **3.4 THE SYNTHESIS TABLE**

##### **Annex 3.1. How to Read the Monograph Synthesis Tables**

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<sup>1</sup> By **Dr Joseph Casas**, Research Director, INRA, Montpellier, France.





For insuring their highest possible degree of quality, objectivity and transparency; for facilitating reading and understanding them; and for allowing a cross-country analysis, all the monographs had to be concise (from about 5 to 6 pages for the small NARSs to about 15 pages for the largest ones), homogenous and balanced, and had to provide some precise basic qualitative and quantitative information/data.

For these reasons, the four institutions which sponsored the study decided that the monographs had to be prepared by national teams made up of small numbers of highly qualified national consultants<sup>1</sup> according to precise guidelines prepared by the scientific editor of the study.

The guidelines specified the expected size and contents of the monographs, and a proposed methodology adapted from similar previous regional studies, especially those conducted by CIHEAM (Istanbul, 1987) and FAO (West and Central African NARSs, 1993), and from many NARS reviews done by CIHEAM, FAO and ISNAR.

The following notes describe the main features of these guidelines. They first present the main contents of the monographs (Section 3.1) then consider the definition of a NARS and the categories of its scientific and technical institutions (Section 3.2). Then a description of the concepts and definitions related to the human and financial resources of the NARS follows, with a brief assessment of the advantages and drawbacks of the method used to calculate these resources (Section 3.3). Section 3.4 is related to the synthesis tables which represent a summary of each monograph.

### 3.1 CONTENTS OF THE MONOGRAPHS

Each monograph has five sections which present:

- (i) A brief historical background of agricultural research (AR) in the country.
- (ii) The current structural situation of the NARS. This section is the main one of each monograph and includes:
  - a first sub-section which gives an overview of the relative importance of the three large categories of scientific and technical institutions (STIs) making up the NARS (AR institutes, faculties of agricultural sciences, and other institutions: see the definition of these categories below) and of the bodies/organizations responsible for the national scientific and agricultural research policies, when they exist;
  - a second main sub-section which consists of a set of concise descriptions of the NARS STIs, recording (at least for the most important ones) their mandate and organization; their human, physical and financial resources; their AR activities and programs; and their national and international linkages.
- (iii) An analytical overview of the human, physical and financial resources of the NARS, with an estimate of the total number of potential research years (see explanation in Section 3.3 below) and consideration of the academic level of the different STIs; an estimate of the financial resources allocated to AR (national funds, loans, foreign grants, total funds); and the ratios of national funds to agricultural gross domestic product (AGDP) and total funds to AGDP, which are essential for appreciating the relative importance of the efforts allocated to AR in the country.
- (iv) An analytical overview of the AR activities/programs of the NARS, scientific results, relations with development organizations, impact on agricultural development, and national and international linkages.
- (v) A brief statement on the NARS, which stresses its main strengths and weaknesses and its future prospects.

Each monograph is complemented by a synthesis table (with additional tables for the major NARSs), which summarizes the NARS monograph, and a list of the main bibliographic references related to the NARS.

For facilitating their task, the national teams received these guidelines with examples of monographs prepared in previous regional NARS overviews (prepared by FAO and CIHEAM), as well as questionnaires on the AR institutes and faculties of agricultural sciences and a provisional, incomplete list of available bibliographic references compiled by the scientific editor of the study.

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<sup>1</sup> There were two or more national consultants per country (according to the size of the NARS), generally chosen by the country in consultation with ICARDA, from among scientific leaders of different important national institutions (for example, one from an AR institute and one from a faculty of agriculture), recognized as such in their country and often having previous experience in writing such paper.

### **3.2 CONCEPTS/DEFINITIONS RELATED WITH NARS STRUCTURE**

In this section, a definition of the public NARS and the categories of the national institutions making up the NARS is presented.

#### **3.2.1 Definition of the Public NARS**

In the most accepted definition, a NARS includes all the national public scientific and technical institutions (STIs) which undertake or include AR activities<sup>1</sup> in their mandate; their resources are limited to those mobilized by the AR activities, without considering those allocated to other activities and mandates. In a broader definition, a NARS includes, in addition to the national STIs, the national political and administrative authorities (ministries/bodies) that help to define, fund and monitor the national AR policy.

Although the two definitions are rather close, the broader definition has the advantage of explicitly recording the significance of the governance organizations in the structural analysis of the NARS. In this study, both definitions exclude, as mentioned in Chapter 1, private and international STIs. However, exceptions have been made in the study when private STIs operate under the governance of ministries and with some public support (e.g., the case of some faculties of agricultural sciences in Lebanon) and when international STIs are operated and funded mainly by one country (e.g., the case of some AR institutes in Turkey).

#### **3.2.2 Categories of National Institutions Making up the NARS**

The study includes three main categories of public national STIs making up a NARS: the AR institutes, the faculties of agricultural sciences, and the other institutions. The relative importance, number, and size of these institutions will be considered in the cross-country analysis (see Chapter 9) for defining the concepts of "fragmentation or concentration, integration, and typology" of the NARS.

The formal definitions of these three categories of STIs are given below, followed by the problems of certain borderline cases.

#### **Agricultural Research Institutes (ARIs)**

This category covers AR "institutes, directorates, departments, services, and units" that have AR as their main mandate, which means that their scientific and technical graduate staff allocates at least 50% of its time to AR activities. Other mandates, carried out to a minor proportion, may cover other activities such as development and service activities (extension work; seed, plant and vaccine production; soil/water/feed analyses; consultations; studies; etc.), "current" agricultural production (other than that of seed and seedlings), and academic or professional training.

In the West Asia and North Africa (WANA) region, three types of ARIs exist according to their degree of specialization

- Multicommodity and multidisciplinary ARIs, the most numerous ones, with a mandate covering a wide range of AR fields, at least crop and livestock production, and often other spheres (production systems, agricultural socioeconomics, etc.).
- Specialized ARIs, with a mandate confined to one commodity or group of similar commodities (for example, cereals, cotton, horticulture, animal production and health, fisheries, etc.), one scientific discipline or group of disciplines (phytopathology, crop protection, agro-food technology, agricultural economics), or one production or resource factor (soil, irrigation).
- Semi-specialized ARIs: those in an intermediate position, with mandates covering at least one major AR sector and one related sector.

The administrative/judicial status and organization of the ARIs are diverse as indicated below:

- Autonomous ARIs, endowed with a public administrative status, a board of trustees, a well-defined budget, and specific management rules. In the small and medium-size countries, these autonomous ARIs are "simple," made up of non-autonomous specialized divisions, departments or units (INRAA in Algeria; ARC, ASRC and MBRC in Libya; INRA and INRH in Morocco; ARC, DRC and NIOF in Egypt; ARC and ARRC in Sudan; ARI in Cyprus; SBAR and CWSR in Iraq; NCARTT in Jordan; LARI in Lebanon; AREA in Yemen; etc.). In some countries, generally the largest ones, we find "multi-organizational" ARIs which govern or coordinate several

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<sup>1</sup> In this publication, AR activities cover research on food/agricultural commodities (crops, forestry, animal production, inland and marine fisheries) and all scientific disciplines related to these commodities and to natural resources (soil, water, agro-food technology, and human resources (rural socioeconomics)).

other institutions (examples: ARC in Egypt, AREEO in Iran, and GDAR and GDRS in Turkey, which govern semi-autonomous ARIs; IRESA in Tunisia which oversees four ARIs and nine agricultural graduate schools).

- Non-autonomous “institutes, divisions, departments or units,” governed by administrative bodies (ministry, ministry department/division), with a low margin of autonomy/flexibility in resource management, such as CNRF and SEEN in Morocco; DARHRD in Entrea; DASR, DS, DIWU, DCB and CDCB in Syria; ARD in Bahrain; and ARC in the United Arab Emirates.

## Faculties of Agricultural Sciences (FASs)

These are university-level institutions (called faculties, colleges or “higher schools,” according to the country) that grant diplomas and degrees in the agricultural and food sector or in veterinary medicine, with courses lasting at least four years. In the WANA region, this category includes:

- In almost all countries, “Multisectorial/multidisciplinary” FASs, with a mandate covering a broad range of agricultural sciences, at least crop and livestock production and some other spheres (natural resources, forestry, agricultural mechanization, rural economics, etc.).
- In the largest countries (Egypt, Iran, Turkey, etc.), other FASs specialize in veterinary medicine, forestry, and agricultural and food industries.

Institutes that confine themselves to training senior agricultural technicians are excluded here, as they generally do not have highly qualified staff able to implement AR activities.

## Other Institutions (OIs)

This category includes the other scientific and “technical” institutions that have AR as a second or minor mandate.

The other scientific institutions are institutions of research and/or advanced training which have agricultural sciences merely as a secondary sphere of activity. Some examples found in the WANA region are:

- Multisectorial/multidisciplinary research institutes or centers, with some branches partly or totally specialized in AR-related fields (examples: NRC and NWRC in Egypt; the nuclear energy organizations or research institutes in Egypt, Iran, Iraq, Syria and Turkey, which devote a small part of their resources to research applied to soil, plant improvement and food technology).
- The socioeconomic research institutes, partly involved in rural socioeconomic (Jordan, Sudan).
- Numerous faculties of science, technology, engineering, economics, arts, etc., which have some departments, units and/or a minority of academic staff members specialized in biological and other sciences directly concerned with the rural environment (botany, genetic resources, biological pest control, hydrology/irrigation, food and agricultural technology, agricultural mechanization, rural economics, sociology and geography, etc.).

The other “technical” institutions are permanent or sometimes temporary institutions in which development or development support is their main mandate, but which also have research or research–development units or implement AR activities, even when those activities are not explicitly mentioned in their official mandate. In the WANA region, they consist of sectorial “research–development” institutes or directorates; sectorial or regional development projects (the huge GAP in Turkey, numerous relatively small projects in Yemen); sectorial development directorates, services or projects (remote sensing centers in Lebanon, Libya, Syria; soil directorate and water agencies/directorates in Tunisia; veterinary laboratory in Ethiopia, etc.); or public agro-industrial enterprises (cotton in Syria, tobacco in Iran and Turkey, etc.).

## Borderline Cases

The boundaries between the above three categories may be blurred, as the following examples show:

- Despite their confusing official names, some ARIs have been classified in the OI category, as they are more involved in development than in research (e.g., the Algerian agricultural research–development institutes mainly involved in seed production and extension).
- Some ARIs attached to universities, such as WERSC and MSS (University of Jordan, Amman) and MRI (Lattakia University, Syria), have been classified in the ARI category because of their autonomy within the universities and their strong commitment to research.
- Within some scientific OIs, specialized directorates or departments are clearly specialized in AR fields. They have been considered as ARIs when they enjoy a large degree of autonomy (three AR institutes affiliated to the

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<sup>1</sup> IAV Hassan II of Morocco is the unique fully “multisectorial/multidisciplinary” FAS of the WANA region as it also covers veterinary medicine and fisheries.

Sudanese NCR, NCMS affiliated to the Lebanese NCSR) or classified in the OI category when they have limited autonomy (example: the agricultural units of the nuclear energy research institutes mentioned above).

- The importance of the mandates of a NARS institution may change over the years: the Tunisian soil and water directorates are considered as OIs as their development activities currently dominate, while their research mandate was more important some years ago.
- Institutions having the same name in different countries may be classified under different categories: the institutes of nutrition and food technology have been considered as ARIs in Iran and as OIs in Tunisia according to the relative importance of their research (numbers of researchers) related with either food or other fields (human nutrition/ medicine).
- Within the category of "other institutions" it is not always easy to distinguish between scientific and technical institutions (CFRDs in Morocco; the remote sensing centers in Lebanon, Libya, Syria).

### 3.3 CONCEPTS/DEFINITIONS RELATED WITH NARS HUMAN AND FINANCIAL RESOURCES

#### 3.3.1 NARS Human Resources

The monographs focus on graduate scientific and technical staff members<sup>1</sup>, those who hold a university or higher degree (PhD, MS, diploma or BS, acquired after at least four years of university study) in agricultural fields. The monographs extensively use the concepts of research years (RYs), potential RYs (pRYs) and actual RYs (aRYs).

##### Potential Research Years

One pRY is the equivalent of a full-time researcher (for one year). The total pRYs of a NARS are the sum of the estimated AR pRYs of each of its STIs.

For the ARIs, the number of its pRYs was estimated by multiplying the number of its graduate scientific and technical staff members on duty by the average percentage of time they devote to AR (% estimated by the ARI directorates<sup>2</sup>). In the (few) ARIs fully engaged in AR activities (100% of their time devoted to AR), the number of pRYs is equivalent to the number of researchers<sup>3</sup>.

Scientists who were on full-time study leave in their country or outside were not included in the pRYs for the year considered in the monographs (examples: Jordan, Libya, etc.).

For the FASSs, the number of its pRYs was estimated by multiplying the number of full-time academic staff members by a 25% normative average percentage of time potentially devoted to AR. This flat rate was adopted because, in most of the FASSs of the WANA region, this percentage was generally mentioned by their deans as a normative professional commitment for insuring that teaching remains scientifically relevant and suited to national situations.

Although this normative percentage may appear arbitrary, it was the simplest method for evaluating the AR pRYs of the FASSs in order to add them to the pRYs of the other categories of NARS institutions. In any case, in most of the WANA countries, it has been observed that the actual commitment of the academic staff members is much lower because of many constraints and limitations (lack of funds for research, lack of time due to the heavy teaching loads, lack of personal financial incentives, etc.).

For the OIs, the number of pRYs was estimated differently depending on the type of institutions concerned. In the case of the scientific OIs, the pRYs were estimated by a procedure similar to that used for the ARIs or FASSs, depending on whether they were research or teaching institutes and on the number of scientists (researchers or professors) involved in agricultural sciences. In the technical OIs with specialized AR units, estimates take into account the number of specialized graduate research staff in these units or the total number of graduate research staff and a rough estimate of the percentage of time allocated to AR activities.

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<sup>1</sup> The description of the largest NARS institutions generally gives some information (numbers) on and assessment (qualifications) of the support staff, essentially the technicians and staff with low qualifications (clerks, laborers, drivers, etc.).

<sup>2</sup> Sometimes this percentage was estimated by dividing the number of graduate staff members belonging to AR departments, divisions or units (thus excluding those working in service or production units) by the total number of graduate staff members.

<sup>3</sup> In previous similar studies (Sub-Saharan and Mediterranean countries), it was assumed that a researcher specializing fully in AR (1 researcher = 1 pRY) can devote up to 10% or even 20% of his or her time to other activities (development, extension work, studies, advanced teaching, etc.). Practiced on a reduced scale, such activities are natural complements to AR activities and are particularly helpful in improving their orientation and extending awareness of their results. But with this assumption, it would have been difficult in the present study to differentiate between ARIs in which researchers are supposed to devote 70 or 80% of their time to AR activities.

## Actual Research Years and Actual Employment Rates of the Scientific Potential

In each monograph, the pRYs were converted into aRYs, based on the estimated actual employment figures of the scientific potential. These aRYs were calculated for each of the main STIs of the NARS taking into account different criteria.

For the ARIs, the main criterion was the available operating and capital costs (OCC)<sup>1</sup> per pRY. Comparing this ratio with the generally accepted average rates of US\$ 25,000–30,000 per pRY per year used in drawing up medium- or long-term national AR plans provides a tentative idea of the actual employment rate; this reference figure means that if an ARI has only US\$ 10,000 per pRY, its aRYs can at best represent only 33 to 40%<sup>2</sup> of its pRYs<sup>3</sup>.

For the ARIs where it was not possible to estimate the OCC per pRY, and for all other institutions (FASs, OIs, etc.), other criteria were used, such as the actual employment rate directly estimated by the directorates or by some senior staff leaders in the countries, or the material resources available (in an ARI endowed with good material resources, pRYs and aRYs are equal; on the other hand, in ARIs with poor material resources, the aRYs are much less than the pRYs and very roughly estimated accordingly).

The actual employment rate of the scientific potential of the NARS was roughly estimated by dividing the total aRYs by the total pRYs. Despite its approximate nature, this ratio constitutes the most comprehensive yardstick of the degree of “quantitative efficiency” of the NARS.

### 3.3.2 NARS Financial Resources/Expenditures

The estimated annual AR financial resources of a NARS are the sum of these resources as estimated for each of its STIs. These individual estimates were made by adding together the various categories of AR resources or expenditures (E): national expenditures (NE), loans (LE), and foreign expenditures or subsidies/grants (FE), to obtain the total expenditures (TE). With few exceptions, they were made in local currency and then converted to US dollars. NE and TE were later used for estimating the ratios NE/Agricultural Gross Domestic Product (AGDP) and TE/AGDP, which are the best ratios for assessing the extent of national AR efforts and for proceeding to cross-country comparisons (see Chapter 9).

#### National AR Expenditures

For the ARIs, the first step was to calculate their total budget, which generally includes public/budgetary allocations from the government and their own resources:

- Public budgetary allocations: In some countries, all these allocations (staff, operating and capital expenditures) are paid to the ARI budget, while others receive only the sums earmarked for operating and capital costs, with permanent staff being paid directly by some government body (the Ministry of Agriculture, the Ministry of Treasury, etc.).
- Their own resources: These are the resources generated by AR contractual activities financed by national public and private organizations (development agencies, farmers’ cooperatives, private agro-food companies, etc.), the sale of copyrights and publications (a small fraction of the resources), production and/or development activities (seed, plant and vaccine production; production resulting from experimental activities; in some cases routine production undertaken for valorizing available land resources), services (soil/water/feed analyses, soil studies, socioeconomic studies, etc.), education (academic training and refresher courses), etc.

The task of calculating the national AR expenditures of a given ARI on the basis of its total budget/expenditures varies depending on its mandate, as shown in the following:

- For an ARI specializing solely in AR and devoting itself essentially to AR activities, and with resources of its own being drawn mainly from these activities (research contracts, sale of agricultural products resulting from experimental activities, etc.), the AR financial resources are equivalent to the total budget.
- For an ARI with mandates other than research, at the beginning of the study, and as for similar previous studies, NE was calculated by applying a coefficient to the total budget reflecting the proportion of AR activities within the overall activities of the ARI, e.g., for an ARI whose graduate scientific and technical staff allocate 70% of their time to AR, NE amounts to 70% of its total budget. However, this mode of calculation certainly underestimates NE, as most of the other activities (production, services, etc.) are less expensive than research activities. Therefore, it was decided to calculate NE by the following formula:  $NE = \text{total budget} \times [\alpha +$

<sup>1</sup> OCC represents the outlay of an institution except for the “permanent staff” expenditure. It covers the “support costs” of researchers (their direct working resources), the general expenses of the institution, the depreciation of infrastructure and equipment, the hiring of seasonal staff, etc.

<sup>2</sup> US\$ 10,000 divided by US\$ 30,000 and by US\$ 25,000, respectively.

<sup>3</sup> Comparing the OCC per pRY available for a whole NARS and these norms can also provide a very rough idea of the actual employment rate; however, it is generally not easy to evaluate the total OCC of a given NARS.

$0.5(100\% - \omega)$ , where  $\omega$  is the percentage of time devoted to AR by the graduate staff, which means that for an ARI whose graduate staff allocates 70% of its time to AR, NE amounts to 85% (intermediate value between 75 and 100%) of the total budget. The first mode of calculation (% of time allocated to AR multiplied by the total budget) was used only for the few ARIs specialized in veterinary medicine and which are involved in vaccine production (an expensive activity), and in agricultural socioeconomics, for which the other activities consist mainly of studies having costs similar to those of research.

For the FASs and OIs, the method followed for estimating NE was very similar to that used for the ARIs, with some modifications. For an FAS, national AR expenditures (NE) were assumed to be proportionate to the actual percentage of time allocated by the graduate staff to AR activities. Thus, with a percentage of 10 (roughly estimated for many FASs), NE was 10% of the total budget of the FAS. For the scientific OIs, NE was assumed to be proportionate to the ratio of the percentage of graduate staff specialized in AR activities to the total graduate staff. For the other OIs, NE was generally directly calculated by using all the available information on the OI. For the OIs which did not provide their budget data, NE was estimated based on the average costs of the national and expatriate RYs.

### **Other Financial Expenditures**

Expenditures/Resources from Loans (LE) - In the case of loans (granted generally by the World Bank in Jordan, Morocco, Tunisia, Turkey and Yemen), reference was made both to the information found in the annual reports of the ARIs concerned and the annual installments due under the planned loan (taking into account possible delays in such payments), as well as to a simple division of the total amount of the loan by the number of years covered.

Foreign Expenditures/Resources (FE) - This heading covers grants for operating and capital costs (funds earmarked for the budget of the national institution or items directly financed by the donor: donations of plant products, etc.); training and mission expenses, etc.; the free provision of qualified expatriate staff, and sometimes the payment of certain expenses of national staff. The gross sum of such subsidies was calculated by taking into account all available information. In cases where precise information was lacking and also for the provision of expatriate staff, standard costs per expatriate were used, since these are fairly well known for the main aid agencies.

### **3.3.3 Drawbacks and Advantages of the Method Used in Calculating the NARS Resources**

#### **Margins of Error in Calculating the Resources**

Due attention was given throughout the study to the calculation of human and financial resources (pRY and aRY; NE, LE, FE, TE) allocated to AR by the NARSs, leading to successive versions of the monographs in attempts to improve the quality and reliability of the data. However, there should be no illusion of complete accuracy of the data. Depending on the institutions and concepts used, the margins of error, in general, are:

- fairly small for ARIs almost fully engaged in AR activities, even those with a relatively wide range of activities, and small for FASs, but greater for OIs;
- smaller for large NARSs, where the levels of resources are generally rather stable, than for small NARSs, which can exhibit relatively large variations in resources over the years;
- smaller for the large institutions (which received greater attention in this study) than for small institutions (for which some figures should be seen as simply indicative);
- smaller in estimating pRYs than aRYs, and NE than LE and FE; globally, those margins of error may reach 10 to 20% for pRYs and for NE and TE, and 20 to 30% (if not more) for aRYs and FE.

Another margin of error may have originated when the calculated financial resources were converted to US dollars, using the official rates for the year of reference (over-evaluated for some countries).

The essential point was to be as consistent as possible in processing the gathered information, particularly by using the same methods of calculation; this was the main task of the scientific editor of the study.

#### **Advantages of the Concepts Used**

Despite its conventional approach and approximations, the methodology offers many advantages. Above all, it results in more complete and accurate monographs than those delivered in previous studies related to the WANA region (FAO and ISNAR, 1990), which confined themselves mainly to the human and financial resources of the ARIs (without taking into account the extent of activities other than AR), and without taking into account the FASs and OIs, or without adding/integrating the data related to all categories of institutions.

The methodology also gives a precise idea of the structure of the NARS and the human and financial resources mobilized by the NARS, and proposes some criteria which allow assessing each NARS and comparing between the different ones.

### 3.4 THE SYNTHESIS TABLE

The synthesis table (with more tables attached for the larger NARSSs) is a simple tool for allowing a comprehensive harmonized presentation of the NARS structure and resources, and for the cross-country comparison presented in Chapter 9. [Annex 3.1](#), "How to Read the Monograph Synthesis Tables," may be useful for understanding them.

#### Acronyms of the NARS Institutions

Algeria: INRAA: Institut National de la Recherche Agronomique d'Algérie.

Libya: ARC: Agricultural Research Center. ASRC: Animal Studies and Research Center. MBRC: Marine Biology Research Center.

Morocco: CNRF: Centre National de la Recherche Forestière. IAV Hassan II/Rabat: Institut Agronomique et Vétérinaire Hassan II. INRA: Institut National de la Recherche Agronomique. INRH: Institut National de Recherche Halieutique. SEEN: Service de l'Expérimentation, des Essais et de la Normalisation.

Tunisia: IRESA: Institution de la Recherche et de l'Enseignement Supérieur Agricoles.

Egypt: ARC: Agricultural Research Center. DRC: Desert Research Center. NIOF: National Institute of Oceanography and Fisheries. NRC: National Research Center. NWRC: National Water Research Center.

Eritrea: DARHRD: Department of Agricultural Research and Human Resource Development.

Ethiopia: EARO: Ethiopian Agricultural Research Organization.

Sudan: ARC: Agricultural Research Corporation. ARRC: Animal Resources Research Corporation. NCR: National Center for Research.

Cyprus: ARI: Agricultural Research Institute.

Iraq: SBAR: State Board for Agricultural Research. CWSR: Center for Water and Soil Research.

Jordan: NCARTT: National Center for Agricultural Research and Technology Transfer. MSS: Marine Sciences Station. WERSC: Water and Environment Research and Study Center.

Lebanon: LARI: Lebanese Agricultural Research Institute. NCSR: National Council for Scientific Research. NCMS: National Center for Marine Sciences.

Syria: CDCB: Central Directorate of Citrus Bureau. DASR: Directorate of Agricultural Scientific Research. DCB: Directorate of Cotton Bureau. DIWU: Directorate of Irrigation and Water Use. DS: Directorate of Soils. MRI: Marine Research Institute.

Iran: MOJC: Ministry of Jihad Construction. MOC: Ministry of Commerce. MOH: Ministry of Health. AREEO: Agricultural Research, Education and Extension Organization.

Turkey: GDAR: General Directorate of Agricultural Research. GDRS: General Directorate of Rural Services. ARI: Agricultural Research Institute.

Bahrain: ARD: Agricultural Research Directorate.

United Arab Emirates: ARC: Agricultural Research Center.

Yemen: AREA: Agricultural Research and Extension Authority.

#### References

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### Annex 3.1 - How to Read the Monograph Synthesis Tables

These notes are based on the synthesis table of the **Moroccan NARS as an example** (for the other countries, see the final remark in this annex).

a: Number: This normally refers to the code used for identifying the categories of the scientific and technical institutions of the NARS, indicating their nature as follows:

- 1: polyvalent or multisectorial ARI;
- 2: specialized ARI;
- 3: FAS, without distinction of its degree of specialization;
- 4 and 5: other NARS institutions (scientific and technical institutions, respectively).

b: Name - Acronym - Head Office - Year Established: The complete names of the STIs, often not given in full in the synthesis table due to the lack of space, are found in the list of acronyms given at the end of each monograph. The head office indicates the city where the directorate of the STI is located. The year is that of the creation of the STI; when two dates are given, the first is that of the creation of the earliest forerunner of the STI, the second, that of the STI under its present name and/or status.

c: Mandate: The abbreviations used correspond to the various mandates of the STI (in order of importance); parentheses indicate a relatively secondary or marginal mandate. For the ARIs and some FASs and OIs, percentages will sometimes be found in parentheses after the abbreviation AR, corresponding to the approximate average time devoted to this activity by the graduate scientific and technical staff of the STI concerned (based on information provided by the STI leaders). The main abbreviations used to indicate the sphere of activities are as follows:

AD	Agricultural Development
AHE	Agricultural Higher Education (graduate studies)
AHME	Agricultural High and Medium Education (including training technicians)
AR	Agricultural Research
HE	Higher Education (graduate studies)
R	Research

AR Fields: The main sectors of AR are given, the following terms or abbreviations being the most frequently used:

All	A majority of AR spheres (with some exceptions, as indicated in the monograph)
Crop prod.	Crop production
Livest. or anim.	Animal production
Rural socioc.	Rural socioeconomics
Various	See monograph

d: Governing Ministry: Acronyms of the ministry or public organization in charge of the STI, the full name being given in the list of acronyms at the end of the monograph.

e, f, g: Graduate Scientific and Technical Staff: e: total number of nationals; f: numbers of national PhD and MS holders; g: number of expatriates.

h, i: Potential Research Years: provided by nationals and expatriates.

j, k: Total Budget: generally given only for ARIs and FASs.

l, m, n, o: AR Budget or Expenditures/Resources: NE: national expenditures; FE: foreign grants.

#### Other Observations:

Numbers in italics: Approximate numbers; ...: Data not available; \*: See table footnotes.

#### Final Remark:

For other countries, the alphabetical letters used in the synthesis table may change according to the specific characteristics of their NARS; for example, in some NARSs, there are no expatriates or foreign financial resources.

4. MONOGRAPHS OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEMS OF NORTH AFRICA

**ALGERIA**

**LIBYA**

**MOROCCO**

**TUNISIA**



# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF ALGERIA<sup>1</sup>

## 1. HISTORICAL BACKGROUND

The NARS of Algeria has about 30 autonomous institutions, the most important of which are affiliated to the Ministries of Agriculture and Fisheries (MAP) and Higher Education (MES).

The evolution of the agricultural research (AR) structure of MAP has been marked by the reorganization of the National Institute of Agricultural Research of Algeria (INRAA: *Institut National de la Recherche Agronomique d'Algérie*) and the creation of research-extension institutes, called "technical" institutes (ITs), mainly from INRAA's human and physical capacities. There were six crop production ITs created in 1974 and five livestock ITs founded later; their mandate included applied research and technology transfer through extension activities and development support (mainly seed production, control and certification). This mandate was successfully carried out during the first years despite the youth of the ITs and their senior staff's low qualifications.

Over the years and until 1982, extension and seed production became the main activities of the ITs, and research activities became almost marginal. From 1982 to 1986, research was abandoned. After 1986, it was decided to apply a process of reorganization, which took place in 1987.

## 2. ANALYSIS OF THE NATIONAL RESEARCH-DEVELOPMENT SYSTEM

NARS organization is characterized by significant fragmentation and total compartmentalization between different institutions of different sectors. This fragmentation originated from inadequate coordination and insufficient regional and national integration. Structural mutations of the ITs led to the predominance of administrative over scientific hierarchy. Being edged out, the role of researchers became marginal.

In the NARS institutions affiliated to MAP, the number of available research years is relatively low. Moreover, the scientific level of their graduate staff members remains very low (most of them are BS holders) because hiring conditions (salaries, scheme of career) are far below those of the academic institutions. This also explains the lack of integration of academic staff members in research activities of the MAP institutions.

## 3. CURRENT NARS RESEARCH ACTIVITIES

AR is essentially linked to MAP and MES. At the national level, the High Commissariat of Research (HCR: *Haut Commissariat à la Recherche*), affiliated to the Presidency of the Republic, has the mandate to coordinate research programs of all the sectors and ministries.

### 3.1 Institutes Affiliated to the Ministry of Agriculture and Fisheries

The MAP AR system is made up of complementary public autonomous institutions: INRAA, six technical institutes, two prevention and protection institutes, and one fishery research and study center (CERP). Coordination is handled by two councils run by MAP Education-Research-Extension Directorate (DFRV: *Direction de la Formation, de la Recherche et de la Vulgarisation*): the Scientific Council of Agricultural Research-Development (CSRDA) and the National Council of Agricultural Extension (CNVA).

For research implementation, the MAP institutions have research stations and laboratories and 61 experimental stations. Their budget is allocated by the Government.

For extension activities, the institutions are supported by the National Agricultural edagogic Center (CNPA: *Centre National de Pédagogie Agricole*), the Agricultural Training and Extension Center (CFVA: *Centre de Formation et de Vulgarisation Agricoles*), local agricultural development public structures (agricultural directorates, services, projects), specialized cooperatives, and pilot farms affiliated to MAP directorates (185 farms covering 190,000 ha).

### National Institute of Agronomic Research (INRAA)

With its five departments (soil/bioclimatology, phylogenetic resources and crop breeding, animal husbandry and selection, rural economics and sociology, biometry and computer science) and a documentation and external relations service, INRAA is in charge of basic research. It develops scientific programs of common interest to the technical

<sup>1</sup> Prepared in October 1997 by Mr Abdelkader Benbelkacem, Engineer at ITGC Experimental Station, Khrub/Constantine.

institutes, which currently focus on agronomy (soil fertilization, mineral amendment of saline soils), genetic resources (cereals, legumes, forages), and tissue culture (date palm).

### Technical Institutes

There are six technical institutes (ITs) specialized in field crops (ITGC), vegetables and industrial crops (ITCMI), fruit trees (ITAF), bovine and ovine (ITEBV), small livestock (ITPE) and Saharan agriculture (ITDAS).

These institutes have stations and laboratories working on production constraints. They are also in charge of applied research activities induced by the agricultural intensification program, mainly the elaboration of norms of production factors, adaptation and development of efficient techniques, production and conservation of genetic crop and animal resources, control and certification of these resources, training of extension staff, etc.

Each IT is organized into specialized units (in the crop IT: seed/seedling production, applied research, studies and programming, extension support) assisted by an administrative/financial department. The ITs are supported in their scientific and resource management affairs by scientific councils and "orientation/management" councils.

### Protection and Prevention Institutes

Besides their research missions, the National Institutes of Crop Protection (INPV) and Animal Health (INSA) are in charge of crop and animal protection from diseases and pests; this includes sanitary control and protection, product control at the borders, certification of chemicals and pesticides, and epidemiology and pest control against the main predators (locusts, cereal aphids, animal tuberculosis and brucellosis, etc.)

### 3.2 Agricultural Graduate Training Institutions

Among the graduate training institutions, the most committed to AR are the National Agricultural Institute (INA) of Algiers, with its AR unit (URSA), and the University of Sciences and Technology of Algiers (USTHB), with its arid zones research and biology units (URZA and URBAT, respectively).

The research units are coordinated by a research directorate set up by MES. Each one has a scientific council and manages financial resources provided by its institution (INA, USTHB).

## 4. NARS RESOURCES

### 4.1 Human Resources

NARS qualified human resources are very limited and anarchically mobilized. There is a total of around 350 research years (RYs) distributed between the institutions affiliated to MAP (INRAA, IT, ITAS, ITA, BNEDER, with 175 RYs), MES (INA, other graduate agricultural schools, universities, etc.), and the Ministry of Water and Environment (ANRH, ANPE).

The highest qualified human resources are available mostly at the universities, which, on other hand, suffer limited physical resources and relations with development organizations. More than 50% of the RYs are concentrated in and around Algiers. In most cases, research stations located in other areas have very few qualified human resources.

The qualifications and research mobilization of the senior staff of the MAP institutes are low: only 6% of the graduate staff members have a PhD. The time allocated to AR varies from 15% at the ITs (such as ITGC) to 2 to 5% in other sectors.

Staff categories		Number	% of total staff
Graduate staff	PhD	28	2.8
	Veterinary specialists	47	4.7
	<i>Ingénieur d'Etat</i> (MS/BS)	156	15.8
	<i>Ingénieur d'application</i> (BS)	233	23.7
Other staff	Technicians	396	40.0
	Clerks, laborers, etc.	75	7.7
Total		985	100.0

#### 4.2 Physical Resources

The national network of experimental farms contains 58 sites with a total area of 6,599 ha. This network is oversized and characterized by many duplications, which implies expensive operation and capital costs. This situation is a result of the current organization of the research system of MAP and compartmentalization at the regional level. The network is also concentrated in some regions and weak or absent in others.

Such a set-up of research sites, in isolation from each other, does not allow organizing research programs that mobilize sufficient qualified human resources nor developing an integrated approach to the regional farming systems in each region.

#### 4.3 Financial Resources

The main financial resources come from the state budget with few external grants (through collaboration with national and international organizations). These resources are made up of operation subsidies and equipment allocations.

### 5. CONCLUSION

This short analysis of the Algerian NARS clearly shows that the system cannot be totally operational unless its structure reaches a certain degree of stability and the situation of the researchers is improved.

In the future, leading research by INRAA must permit rationalizing AR policies and should provide a significant boost to the support and development activities carried out by the technical institutes.

## Complementary Information on the Algerian NARS<sup>1</sup>

### 1. HISTORICAL BACKGROUND

The first institution of agricultural sciences in Algeria was the *Institut Agricole Algérien* (IAA) of El-Harrach/Algiers, created by France in 1889 to train French and European technicians and, later, agricultural engineers, who would contribute to the agricultural colonization of the country. IAA had modern laboratories and services; it remained for a long time the unique agricultural research (AR) center acting in the whole country to support regional services in agriculture.

In 1943, the Agricultural Experimentation Service (*Service de l'Expérimentation Agricole*) was created and endowed with central laboratories associated with those of IAA, and 11 stations well distributed throughout the country. This Service largely concentrated its work on cereal improvement. A few years later, new services (plant protection, livestock, hydrology, fisheries, etc.) created many other specialized research and experimental units<sup>2</sup>. In 1959, the main AR units affiliated to the General Directorate of Agriculture of the "Algerian Government" (which ran the country as a French region) were attached to the National AR Institute of France (INRA), but INRA did not have time to fulfill its mandate of restructuring and reinforcing the existing system (which had only 72 scientists, including 32 academic staff members of IAA) and to hire Algerian researchers who were totally absent up to that time.

After independence in 1962, most of the administrations bequeathed by France subsisted, but were not operational because of the massive departure of Europeans and the absence of national qualified staff. The Ministry of Agriculture and Agrarian Reform (MARA) created the Algerian Center of Agronomic, Sociologic, and Economic Research (CARASE: *Centre Algérien des Recherches Agronomiques, Sociologiques et Economiques*) that recovered the existing AR units. In 1966, this Center was replaced by the National Institute of Agricultural Research of Algeria (INRAA: *Institut National de la Recherche Agronomique d'Algérie*). However, in the agricultural sector, priority in

<sup>1</sup> This note was prepared (almost two years after the previous monograph) by Dr Joseph Casas, Research Director, INRA, Montpellier, France based on bibliographical references and personal communications mentioned at the end of the note, with the collaboration of Dr Mohamed El Mourid, Regional Coordinator of the ICARDA North Africa Regional Program.

<sup>2</sup> Stations of Boufrik and Sidi-Aïch of the Fruit Service, stations of Tadmit and Khroub of the Livestock Service, station of Hamdenas of the Colonization and Hydraulic Service, station of Bou-Ismael of aquaculture and fisheries, etc.

allocating the few qualified national staff and the numerous expatriates provided by foreign assistance was given to administration and graduate agricultural education institutions: the National Agricultural Institute (INA: *Institut National Agronomique*), which took over IAA<sup>1</sup>, was highly reinforced, and the Institute of Agricultural Technology (ITA, 1969) of Mostaganem and other institutes were created.

From 1974, MARA reorganized its research–development system by setting up specialized "development institutes" (ID) in charge of supporting development (through seed/seedling/vaccine production, crop and animal protection, extensionists' training, applied research, etc.) in the domains of field crops (IDGC), vegetables (IDCM), industrial crops (IDCI), fruit trees (IDAF), small ruminants (IDEO), cattle (IDEB), equines (IDEE), small livestock (IDPE), plant protection (INPV), and animal health (INSA)<sup>2</sup>. The creation of these institutes involved a large transfer of human and physical resources from INRAA, which was left with very few researchers and research domains (soils, Saharan agronomy, medicinal/herbaceous plants, etc.).

The Ministry of Education and Scientific Research (MESRS), established in 1970, set up the National Council of Scientific Research (CNRS) in 1973, which was replaced in 1975 by the National Office of Scientific Research (ONRS), to be in charge of vitalizing the national research policy; but because of many conflicts between ministries, its activity was limited to creating, at the Universities of Algiers, Constantine, Oran and Annaba, many university research centers run by academic staff members<sup>3</sup>. New graduate education institutions were created, mainly the National Veterinary Institute of Algiers (1972) and the Institute of Veterinary Sciences of Constantine (1975), then several national agricultural schools (Batna, Blida, Chlef, Mascara, Targuiet, Tizi-Ouzou).

The creation of the State Secretariat of Forestry and the Ministry of Water, later merged into what became the Ministry of Water and Environment (MHE), induced the establishment of three new institutions: the National Institute of Forestry Research (INRF, 1981), the National Institute of Hydraulic Research (INRH, 1984) and the National Institute for Irrigation and Drainage (INSID, 1984).

The MARA specialized development institutes showed their first weaknesses: they neglected research and could not coordinate their activities at the national and regional level. Therefore, new development organizations emerged in 1981–1982 at both levels (several regional agricultural development offices/projects, High Commissariat of Steppe Development). The period 1982–1986 was a stagnation period for the MARA specialized institutes, basically for two reasons: first, their financial resources decreased due to the economic crisis in the country and, second, qualified staff conditions were not attractive and their qualifications not sufficient<sup>4</sup>.

In 1984, ONRS was replaced by the Scientific and Technical Research Commissariat (CRST), affiliated to the Prime Minister. This new body was rather active: it prepared a national AR program in 1985 covering the agricultural and agro-industry sectors, which was a significant effort for inter-institutional planning and coordination of AR activities. In 1986, it designed a national statute for research staff. In 1987, CRST was replaced by the High Commissariat of Research (HCR: *Haut Commissariat à la Recherche*), affiliated to the Presidency of the Republic.

From 1986 to 1988, the Ministry of Agriculture and Fisheries (MAP, previously MARA) implemented some changes. The Technical Institute for Saharan Agronomy Development (ITDAS) was created in 1986. The development institutes acquired a common statute and were renamed "technical institutes" (IT) and some were merged<sup>5</sup>. In 1988–1990, a reorganization project of the MAP AR system was proposed with the support of the World Bank, without any significant consequences.

Recently, some changes have been made. In 1993, INRAA was designated as the main body responsible for AR within MAP. In 1994, the Research Center for Agro-industry of Blida (CRIAA: *Centre de Recherche sur les Industries Agro-alimentaires*) and the National Agency for Research Development (ANDRU) were created,

<sup>1</sup> When changing its name, the Institute passed from the governance of MARA to that of the Ministry of Higher Education.

<sup>2</sup> To this list we should add the Institute of Vineyards and Wine (IVV: *Institut de la Vigne et du Vin*) created in 1968 from the existing Vine Institute established in 1963.

<sup>3</sup> Among these units are the Biological Resources Research Center (CRBT: *Centre de Recherche sur les Ressources Biologiques Terrestres*), the Applied and Basic Biology Research Unit (URBFA: *Unité de Recherche en Biologie Fondamentale et Appliquée*), and the Arid Zones Research Unit (URZA: *Unité de Recherche sur les Zones Arides*), all created in 1974 by the University of Algiers, and the Research Center of Applied Economics for Development (CREAD: *Centre de Recherches en Economie Appliquée pour le Développement*), established in 1975.

<sup>4</sup> In 1985, INRAA and the development institutes had 43 and 224 graduate staff members, respectively (of whom only 5 and 35 were PhD holders), working mostly in development/extension, and 25 and 72 technicians.

<sup>5</sup> Merging of ITCM (horticulture) and ITCI (industrial crops) into ITCMI (horticulture and industrial crops) and of ITEBO (cattle) and ITOVI (small ruminants) within ITEBO (cattle and small ruminants), and integration of IVV (vineyards and wine) within ITAF (fruit trees).

respectively by the Ministry of Light Industries and MESRS. In 1988, INA of Algiers became the National School of Agricultural Sciences (ENASA). According to the latest data, a national-policy program on scientific research and technology is being prepared that would have positive impact on the NARS situation.

## 2. THE CURRENT NARS

The current (1998) NARS of Algeria is very complex. It is composed of three large groups of institutions (see [Table 1](#)).

- AR institutes: INRAA and CRIAA that have AR as their first mandate; they accumulate only 41 potential research years (pRYs or equivalent full-time researchers), which represent 7% of the total pRYs of the NARS, and mobilize 13% of the total AR financial resources.
- 13 agricultural graduate schools affiliated to the Ministry of Higher Education and Scientific Research (MESRS): they employ 720 academic staff members who represent 160 pRYs and 27% of the total pRYs and mobilize 21% of the total financial resources (see [Table 2](#)).
- The other institutions of NARS, where AR covers only a minor part of their mandate: they represent the major part of the NARS resources (66% of the total pRYs and financial resources). These include:
  - 11 research-development institutes: 8 agricultural institutes within MAP complementary to INRAA, one fishery institute also attached to MAP, and 2 agricultural institutes linked to MHE (INRF, INSID) (see [Table 3](#));
  - other institutions from universities and other sectors (CDTN, CREAD, BNEDER) (see [Table 4](#)).

MESRS, being officially responsible for the national research policy, has some influence on the AR national policy, essentially through its own NARS institutions; but its impact on the other NARS institutions (affiliated to MAP and other ministries) is very limited.

## 3. AR RESOURCES

### 3.1 Human Resources

The Algerian NARS mobilizes around 2110 scientific and technical graduate staff members (gsm), all national, who count for about 580 pRYs. Currently, the best-trained gsms are those of ENASA and other MESRS units that benefited earlier from a favorable statute (career scheme which took into account the academic diploma, higher salaries). The gsm of the institutes of INRAA and MAP received comparable conditions much later (in 1987), which explains their low level of academic qualification.

More than 50% of the RYs of the country are concentrated in and around Algiers. Most of the MAP research centers and stations located "inside" the country have few qualified research teams.

Almost all of the NARS institutions are suffering a large deficit of technicians and other support staff (clerks, laborers, etc.).

### 3.2 Financial Resources

Since only limited data related to the financial resources of the many institutions are available, AR financial resources of the NARS were very roughly estimated. In 1997, they amounted to around 760 billion dinars (US\$ 13.7 million), funded mostly by the Government (foreign contributions were negligible), and would represent about 0.25% of the AGDP (estimated at US\$ 5.4 billion), a ratio which is much less than what is recommended by international institutions (World Bank, European Union, etc.).

At the MAP institutions, a large part of the budget is allocated to salaries. Therefore, the operation and equipment budget is insufficient relative to the potential RYs. At the other institutions, the situation is even worse. Under these conditions, the NARS human resources are only partly mobilized due to the lack of means. The Algerian NARS would therefore represent, at best, 130 to 170 actual research years.

These financial insufficiencies are emphasized by the complicated/slow administrative management procedures and the difficulties in procuring hard currency to buy equipment and spare parts from outside the country.



## 4. RESEARCH ACTIVITIES

### 4.1 Research Activities and Coordination

Since 1989, there has been no precise inventory of the AR programs carried out in the country, therefore, it is difficult to comment on the current breakdown of the scientific potential by main research sectors and commodities, and on how it fits the country's needs. However, some observations can be made:

- Within MAP, the Directorate of Education–Research–Development (DFRV) and the Scientific Council of Agricultural Research–Development (CSRDA) have not been able up to now to fulfil their missions of planning, coordinating and evaluating research programs and activities of the MAP institutions concerned (INRAA, 10 technical institutes, BNEDER) at the national and regional level. The lack of coordination between these institutions and their numerous research sites leads to the juxtaposition of AR programs with obvious gaps and overlaps. It also does not allow using an integrated approach for the necessary intensification of the farming systems in each region. Work on cropping systems in the high cereals plains carried out by ITGC and integrated regional development studies undertaken by BNEDER are good exceptions, but the first could not fully consider livestock systems, and in the latter, there was no follow-up of its studies.
- In most institutions affiliated to MESRS, research programs are mainly individual (conducted either by experienced scientists or young scientists preparing their PhD degree), and the existing scientific councils are ineffective (limited financial resources) or not operational.
- For the two major sub-groups of the NARS, well-planned research programs, implemented with enough human and financial resources needed to achieve significant results, seldom exist.

### 4.2 Linkages with Development and International Scientific Cooperation

Relationships between the NARS institutions and extension organizations at the national and regional level are greatly hampered by:

- the NARS structure (large fragmentation and lack of efficient coordination bodies), the high concentration of human and material resources in and around Algiers, and the relatively low scientific productivity;
- the fragmentation and instability of extension organizations, and the lack of well-organized professional organizations in agriculture in most regions and production sectors.

The relatively large increase in national agricultural production observed since 1980<sup>1</sup> is certainly due less to technical innovations proposed by the NARS institutions than to other factors (privatization of the socialist and cooperative farms, liberalization of agricultural marketing, easier import of inputs and technologies).

International scientific cooperation, which was rather well developed in the 1970s and 80s (FAO, UNDP, CIHEAM, CIMMYT, ICARDA, France, etc.), is currently very limited.

## 5. CONCLUSION

The large fragmentation and lack of integration of the NARS are responsible for many deficiencies reported earlier.

- Weakness of the national mechanisms for planning–programming–evaluation.
- Duality and segregation between the two main NARS sub-groups: MAP institutions with their limited qualified human resources and important physical resources, on the one hand, and MESRS institutions with opposite characteristics, leading to low valorization of all the available resources, on the other.
- Excessive concentration of human and material resources in and around Algiers.
- Insufficient financial resources allocated to AR.

However, the Algerian NARS has accumulated an important human scientific potential that should be manifested as soon as the expected organizational measures are taken (particularly the integration of INRAA and the technical institutes affiliated to MAP).

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<sup>1</sup> Since 1980, the agricultural gross domestic product has been almost doubled, which means a 25% increase of agricultural production per capita (source: FAO).

## Main Acronyms

**MAP:** Ministère (Min.) de l'Agriculture et de la Pêche (Ministry of Agriculture and Fisheries). **MESRS:** Min. de l'Enseignement Supérieur et de la Recherche Scientifique (Ministry of Education and Scientific Research). **MHE:** Min. de l'Hydraulique et de l'Environnement (Ministry of Water and Environment). **DFRV:** Direction de la Formation, de la Recherche et de la Vulgarisation (MAP Education–Research–Extension Directorate).

**ENASA:** Ecole Nationale des Sciences Agronomiques (Alger) (National School of Agricultural Sciences). **INRAA:** Institut National de la Recherche Agronomique d'Algérie (National Institute of Agricultural Research of Algeria). **ITGC:** Institut Technique des Grandes Cultures (Technical Institute of Field Crops).

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Table 1 - The National Agricultural Research System (1996)

*Notes:* Approximate/incomplete data. .... Data not available. ° Rounded numbers. \* See footnotes. All human and financial resources are national.

NARS Institutions				AR Graduate Scientific & Technical Staff (Units)		AR Potential Res. Years (pRY)	Total Budget (million dinars)	AR Expenditures/ Resources (E) (million dinars)	
No.	Name - Acronym Head Office - Year Established	Mandates* AR Fields	Govern. Ministry	Total - (PhD + MS)					
a	b	c	d	e	f	g	h	i	
1.1	Inst. Nat. de la Rech. Agronom. d'Algérie Algiers	INRAA 1914/66	AR (96%) - (AD) All	MAP	35	15	32	90	85
2.1	Centr. Rech. Industries Agro-Aliment. - Bldg	CRIAA, 1994	Food Technol.	MIL	11	...	9	...	13
1.2	Total Agricultural Research Institutes			46	...	41	...	100	
3.1	Ecole Nationale des Sciences Agronomiques Algier-EH-Harrach	ENASA 1898	AHE - (AR: 25%) All	MESRS	170	30 - 120	40°	125	50
3.2	7 Inst. Nat. Enseig. Sup. Agro. Batna, Bldg, ... Tin-Ouzou	ENESA	AHE - (AR: 25%) All	MESRS	200	47	50	565	85
3.3	Inst. Nat. Formation Sc. Agro - Mostaganem	INFSA, 1969	AHE - (AR: 10%) All	MAP	150	15	15	110	14
3.4	3 Inst. de Sciences Vétérinaires Algiers, Batna, Constantine	INV 1972/89	AHE - (AR: 25%) Animal prod./health	MESRS	180	38	45	140	30
3.5	Ecole Nat. des Pêches - Algiers	ENP, 19...	AHE - (AR: 25%) Fish	...	20	...	4	30	5
3	Total Agricultural Sciences Higher Schools (see Table 2)			720	270°	155	970	100	
4.1	8 Inst. tech. de rech.-développement agricole 7 in/around Algiers + 1 in Batna (see Table 3)	IT... 1974/87	AD - AR (25%) All	MAP	604	100	131	640	260
4.2	Cent. Et. R. Appl. Doc. Pêche - Tipaza	CERP, 1953/76	AD - AR (25%) - Fisheries	MAP	17	1	4	15	
4.3	Inst. Nat. Rech. Forestière - Algiers	INRF, 1981	AD - AR (25%) Forestry	MHE	43	8	11	70	40
4.4	Inst. Nat. Sciences Irrigation Drainage - Algiers	INSID, 1981	AD-AR (25%) Water manag.	MHE	30	4	8	20°	
4.A	Total Ag. Research and Research-Development Institutes			694	113	174	735	300	
4.5	University of Algiers: URBEA, CRBT, URZA	USTH/BA	HE - R (AR: Diverse)	MESRS	90	...	45	...	
4.6	Other universities (Constantine, Oran, etc.)		HE - R (AR: Diverse)	MESRS	320	...	80	...	200
4.7	Other scientific institutes (CDTN, CREAD, BNEDER)		R - (AR: Diverse)	...	240	...	80	...	
4.B	Total Other Institutions (see Table 4)			650	...	205	...	200	
4	Total Other Institutions 4.A + 4.B			1344	...	379	...	500	
5	Total NARS (approximate)			2110	...	575	...	760	
Exchange Rate: 100 Algerian dinars = US\$ 1.80 (1997 average rate)					Actual Research Years (Estimate) --->		130-170	AR Expendit. (US\$ million) - -->	13.7

MAP: Ministry of Agriculture and Fisheries. MHE: Min. of Water and Environment. MESRS: Min. of Higher Education and Scientific Research. MIL: Min. of Light Industries.

\*Mandates: AR (... %): Approximate average % of resources devoted to ag. research (AR), AHE: Ag. higher education, AD: Ag. development/services (for AR and AHE institutes: seeds production, soil analysis, extension, studies, etc.).

Total AR expenditures: 0.25% of the Agricultural Gross Domestic Product (AGDP, US\$ 5.4 billion in 1996)

Table 2 - The Graduate Agricultural Schools (1997)

Italics: Approximate data ... Data not available. °: Rounded numbers. \* See footnotes. All human and financial resources are national.

Agricultural Sciences Higher Schools					AR Graduate Scientific & Technical Staff (Units)		AR Potential Res. Years (pRY)*	Total Budget (million dinars)	AR Expenditure/ Resources (E) (million dinars)*	
No.	Name - Acronym Head Office - Year Established		Mandates* Diplomas - AR (%)	Govern. Ministry	Total - (PhD + MS)					
e	b		c	d	e	f	h	j	i	
3.1	Ecole Nationale Sciences Agronomiques Algiers (former INA)	ENASA 1920/98	PhD, MS, BS	25	MESRS	170	30, 120	40°	125	30
3.2	Inst. Nat. Enseig. Sup. Agro., Batna	ENSA - 1970...	BS	15	MESRS	200	47	50	565	85
3.3	Inst. Nat. Enseig. Sup. Agro., Blida									
3.4	Inst. Nat. Enseig. Sup. Agro., Chlef									
3.5	Inst. Nat. Enseig. Sup. Agro., Mascara									
3.6	Inst. Nat. Enseig. Sup. Agro. et Vét., Tarf									
3.7	Inst. Nat. Enseig. Sup. Agri., Tizi-Ouzou									
3.8	Inst. Nat. Enseig. Sup. Agri., Tizi-Ouzou									
3.9	Inst. Nat. de Format. en Sc. Agron., Mostaganem	INFSA - 1969	BS/Technician	10	MAP	150	15	15	110	10
Agricultural High Schools						520	212	165	800	125
3.10	Inst. Nat. Vétérinaire, Algiers (Univ.)	INV/A - 1972	MS	25	MESRS	180	38	45	60	15
3.11	Inst. de Sciences Vétérinaires, Batna (Univ.)	ISV/B - 1987	MS, BS	15	MESRS				30	5
3.12	Inst. des Sciences Vétérinaires, Constantine (Univ.)	ISV/C - 1975	MS, BS	15	MESRS				50	10
B Veterinary Medicine High Schools						180	38	45	140	30
C	Ecole Nat. Pêche (Fisheries), Algiers	ENP/A - 19...	BS	15	...	20	...	5	30	5
D Total Agricultural Sciences Higher Schools (A + B + C)						720	276	155	970	160

MAP: Ministry of Agriculture and Fisheries; MESRS: Ministry of Higher Education and Scientific Research.

\*Mandates: Diplomas - AR (... %). 1. Diplomas delivered by the higher schools (Doctorate, Ing. Etat/Master/MS, Ing. application/BS). 2. Approximate average % of resources devoted to AR.

\* AR potential research years (pRY) and AR expenditures estimated on the basis of the average % of resources devoted to AR by each higher school.

**Table 3 - The Other NARS Scientific and Technical Institutions (1997): The Agricultural Research-Development Institutes (1997)**
*Notes:* Approximate data. °: Rounded numbers. \*: See footnotes. All human and financial resources are national.

Ag. Research-Development Institutes					AR Graduat. Scient. & Technical Staff (Units) Total - (PhD - MS)		AR Potential Res. Years	Total Budget (million dinars) Nat.	AR Expenditures/Resources (E) (million dinars)
No.	Name - Acronym Head Office - Year Established	Mandates *	AR Areas	Govern. Minist.	a	2	b	c	d
1	Inst. Techn. Grandes Cultures, Algiers	ITGC, 1974-87	Field crops	MAP	80	14	151	98	= 640°
2	Inst. Techn. Calt. Maraich. Indust., Algiers	ITCMI, 1974-87	Vegget. ind. crops	MAP	50	12		92	
3	Inst. Techn. Arboriculture-Fruttiers, Blida	ITAF, 1963-87	Fruits, vineyards	MAP	37	3		74	
4	Inst. Techn. Elevage Bovin et Ovin, Algiers	ITEBO, 1976-87	Cattle, small rumin.	MAP	30	2		72	
5	Inst. Techn. Patis Elevages, Algiers	ITPE, 1976	Small animals	MAP	30	2		30	
6	Inst. Nat. Protection des Végétaux, Algiers	INPV, 1975	Crop protection	MAP	187	9		116	
7	Inst. Nat. Santé Animale, Algiers	INSA, 1976	Animal health	MAP	150	35		160	
8	Inst. Techn. Dév. Agron. Saharienne, Biskra	ITDAS, 1986	Saharan agricult.	MAP	21	2	4	36	5
9	Cent. Etu., R. Appl. Doc. Pêche/Aqua, Tipaza	CERP, 1953/76	Fish., aquacult.	MAP	17	1		15	
<b>Total MAP Agricultural Research-Development Institutes</b>					<b>621</b>	<b>86</b>	<b>155</b>	<b>655°</b>	<b>265</b>
10	Inst. Nat. de la Rech. Forestière, Algiers	INRF, 1981	AD - Forestry	MHE	43	8	11	70°	30
11	Inst. Nat. Sc. Irrigation et Drainage, Algiers	INSID, 1981	AD (25%) Water res. manag.	MHE	30	4	8	20°	10
<b>Total Other Agricultural Development Institutes</b>					<b>73</b>	<b>12</b>	<b>19</b>	<b>90°</b>	<b>25</b>
<b>Total Other Agricultural Research-Development Institutes (A + B)</b>					<b>694</b>	<b>98</b>	<b>174</b>	<b>745°</b>	<b>300</b>

MAP: Ministry of Agriculture and Fisheries; MHE: Ministry of Water and Environment; MIL: Ministry of Light Industries.

\* Mandates. AR (- %) = Approximate average % of resources devoted to agricultural research (AR); AD: Agricultural development services (soil analysis, seeds, vaccines, extension, studies).

This list does not take into account the Centre National d'Inémination Agricole et d'Amélioration Génétique (CNIAAG, Algiers, 1988), specialized in animal breeding, mainly involved in development; and the Institut des Sciences de la Mer et de l'Aménagement du Littoral (ISMAL, Tipaza), specialized in fisheries and marine environment (no data available).

Table 4 - Other NARS Scientific and Technical Institutions (1997)

Notes: Approximate/incomplete data. .... Data not available. °: Rounded numbers. \* See footnotes. All human and financial resources are national.

NARS Institutions				Ag. Graduate Scientific & Techn. Staff (Units) Total - (PhD - MS)		AR Potential Research Years
No.	Name - Acronym Head Office - Year Established	Mandates AR Areas	Govern. Ministry			
a	b	c	d	e	f	h
1	Univ. des Sciences et Techniques H. Boumédiène - Algiers/Bab Azouar a. Unité Rech. Biologie Fondamentale et Appliquée, Algiers (Béni-Abbès) * b. Unité Rech. sur les Ressources Biologiques Terrestres, Algiers (Saïda) c. Unité Rech. sur les Zones Arides, Algiers (Béni-Abbès) *	USTHBA - 19... URBFA - 1977 CRBT - 19... URZA - 1974	HE - AR: Genetic res., fish, HE - AR: Semi-arid zones HE - AR: Arid zones	MESRS MESRS MESRS MESRS	90 90	45
a	Univ. Constantine: Inst. Sciences de la Nature (ISN)*, Inst. Sc. Terre (IST)*	UC - 1969	HE- AR: Diverse	MESRS	100 100	20
3	Univ. Annaba: Inst. Sciences de la Nature (ISN)*, Inst. Nat. d'Enseig. Sup. (INES)	UA - 19...	HE- AR: Diverse	MESRS	80 80	20
4	Univ. Sc. et Tech. - Oran: Départ de Biologie Appliquée (DBA) Un. Oran Es-Sénia: Inst. Sciences Nature (ISN)*, Inst. Sciences Terre (IST)*, Inst. Géographie & Aménagement du Territoire (IGAT)	USTO - 1975 UO - 1966	HE- AR: Diverse	MESRS	110 110	25
5	Univ. Béni-Abbès: Inst. Biologie Végétale (IBV) Univ. Tlemcen: Unité Biologie Univ. Tizi-Ouzou: Inst. Biologie		HE- AR: Diverse	MESRS	30 30	10*
A	Total Universities (approximate)				410 410	125
6	Centre de Développement des Techniques Nucléaires, Algiers (IO CSST)	CDTN - 1974	R - (AR: Crop bio., food techn.)	HCEA*	20 ...	20
7	Centre Rech. en Economie Appliquée pour le Développement, Algiers *	CREAD - 1975	R - (AR: 20% Rural econ.)	MPAT	100* ...	10
8	Bureau Nation. d'Etudes et de Développement Rural, Algiers	BNEDR - 1975	AD - (AR: 10% Rural econ.)	MAP	120 ...	50
B	Other Institutions				240 ...	80
C	Total Other Scientific and Technical Institutions (A + B)				650 ...	205

HCEA: High Commissariat for Atomic Energy; MIL: Ministry of Light Industries; MPAT: Min. of Planning and Regional Development.

ISN: Institutes dealing with animal/human biology, etc.; IST: Institutes dealing with geology, soil cartography, regional development, etc.; 7 CREAD (10 scientific/technical senior staff at Algiers + 100 academic staff members around the country working approximately 30% of their time for CREAD).

Note: This table does not take into account some other institutions (no sufficient information available on them), such as the *Institut National des Industries Légères*, Algiers (INIL), a higher education institution run by the Ministry of Light Industries (MIL); the *Entreprise Nationale d'Études Hydrauliques*, Algiers (ENHYD) under MHE; the *Institut National de Vulgarisation Agricole*, Algiers (former CNPA); MAP, the *Unité de Recherche en Mécanisme Agricole* of the *Entreprise Nationale de Production de Matériel Agricole* (URMA), Sidi-Bel-Abbès.

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF LIBYA<sup>1</sup>

## 1. HISTORICAL BACKGROUND

Agricultural Research (AR) in Libya dates back to the early part of this century during the colonial era, where the “Centro Sperimentale Agrario E Zootechnico della Libiya” at Sidi El Masri near Tripoli was established to serve the Italian agricultural settlers.

In the early 1950s to the late 1960s, the Ministry of Agriculture was initiated and AR became affiliated to the Directorate of Plant and Animal Production, with major changes in goals and organization.

In 1969, the Marine Biology Research Center (MBRC, currently affiliated to the Secretariat of Marine Wealth: SMW) was created. The next year (1970) the Agricultural Research Center (ARC) was established by the Ministry of Agriculture (then called the Secretariat of Agriculture: SA) to serve as an umbrella and authorized organization for the implementation of AR in the country with an adopted national AR work plan. Four regional research branches were initiated according to altitude, climatic factors, rainfall, and agricultural activities.

In 1981, the General People's Committee (Minister's Cabinet) initiated the National Authority for Scientific Research (NASR) to formulate and supervise the national research policy, fill in gaps in research not tackled by any existing research institutes and centers, and technically coordinate research carried out at research centers. New research centers were established under the umbrella of NASR, including the Environmental Protection Research Center (EPRC, 1985), the Industrial Research Center (IRC), and the Oil Research Center (ORC).

In 1995, the Secretariat of Agriculture was split into the Secretariat of Agriculture (SA) and the Secretariat of Animal Wealth (SAW), which created in 1996 the Animal Wealth Research Center (AWRC, now called ASRC: Animal Studies and Research Center) to be responsible for research on livestock and wildlife.

Agricultural higher education (AHE) founded its roots with the establishment of the Faculty of Agriculture of Al-Fateh University of Tripoli in 1966. During the period 1975–97, six other faculties of agricultural sciences were created<sup>2</sup>: four faculties of agriculture (FA) at Omar Al-Mukhtar University (Al-Beida, 1975), Sheba University (Sebha, 1987), Al-Tahadi University (Sirte, 1992), and Al-Jabel Al-Gharbi (Zentan, 1997)<sup>3</sup>; and two faculties of veterinary medicine at Al-Fateh University of Tripoli (1988) and Al-Mukhtar University (Al-Beida, 1995).

Other institutions partly involved in AR were also created, among them are the Nuclear Research Center (NRC, established in 1975) and the Libyan Center for Remote Sensing and Space Science (LCRSSS, 1989), both under the Secretariat of Training and Habilitation (STH); and the Economic Studies Research Center (ESRC, 1985), directly affiliated to NASR.

## 2. THE CURRENT NARS

### 2.1 Overview

The NARS of Libya currently (1998) includes three sets of scientific institutes (see Table 1):

- The scientific institutes mainly involved in AR: the Agricultural Research Center (ARC), the Animal Studies and Research Center (ASRC), and the Marine Biology Research Center (MBRC), affiliated to SA, SAW, and SMW, respectively; together they account for around 50% of the potential research years (pRYs: equivalent full-time researchers) and 73% of the total financial resources of the NARS. They are presented in Section 2.2.
- The seven faculties of agriculture and veterinary medicine, under the Secretariat of Education and Scientific Research (SESR), with limited involvement in AR. They meet 38% of pRYs and only 9% of the total financial resources of the NARS (see Section 2.3).

<sup>1</sup> By Dr Taher El-Azabi, Deputy Director General, Agricultural Research Center, Tripoli, and Dr Khaled R. Ben Mahmoud, Professor, Faculty of Agriculture, Al-Fateh University, and Research Coordinator of Al-Fateh University, Tripoli, Libya

<sup>2</sup> In addition, Libya has 13 middle institutes for veterinary medicine and agriculture, the first ones established as early as 1952 at Al-Gheran and Al-Marj.

<sup>3</sup> The FA of Al-Jabel Al-Gharbi (Zentan) was called the Higher Institute for Veterinary Medicine and Rainfed Agriculture, which was created in 1988.

- The "other scientific institutions" mentioned above, affiliated to other secretariats, which allocate some resources to AR (around 12% of the pRYs and 18% of the total financial resources); they will be briefly seen in Section 2.4.

Accordingly, the NARS is relatively highly fragmented among a large number of scientific institutions and secretariats. The National Authority for Scientific Research (NASR) is supposed to formulate and supervise the national research policy, but its actual role in AR is rather limited, and currently no institution is actually responsible for coordinating the NARS.

## 2.2 The AR Institutes

### The Agricultural Research Center (ARC)

Mandate and Organization - ARC is the major institution of the Libyan NARS (42% of the pRYs, and 60% of the financial resources). It is directed (like the two other AR institutes) by a Board of Directors headed by a Director General. Its research activities are coordinated by 8 central departments: soil and water, field crops, horticulture, plant protection, animal production forestry and range, agricultural mechanics, and agricultural economics. ARC researchers allocate around 90% their time to research and 10% to extension and consultancies.

Human, Physical and Financial Resources - ARC has (December 1997) 447 national permanent full-time staff, 136 of whom are research scientists, 218 technicians, and 93 other support staff (clerks, unskilled staff drivers, laborers, etc.).

Out of the 136 research scientists (10 PhD, 30 MS, 96 BS), 124 are on duty and represent 112 pRYs<sup>1</sup>; 9 researchers are on study leaves (5 preparing MS in Libya and 4 preparing MS abroad), and 3 others are on secondment. The scientists' academic level is considered insufficient, but it is improving over the years.

The Center has four "Regional AR Centers" (RARC), supported by 13 experimental stations. The RARCs are responsible for carrying out the research programs.

- The RARC for the western area (which encompasses the largest part of agriculture and of the population), was established in 1971 at Tajura, 20 km east of Tripoli. It covers the areas from the Tunisian borders to Khomes region (6 research stations and 3 experimental sites), and employs 85 researchers who focus mainly on fully irrigated and supplementary-irrigated crops such as vegetables, cereals, fruits, and forages, with some emphasis on rainfed agriculture as well as agroecology, animal production, and biotechnology.
- The RARC for the eastern area, established in 1972 at Al-Marj, 1100 km east of Tripoli, covers the areas from Sirte to the Egyptian borders (4 stations). It has 30 researchers mainly in rainfed agriculture (cereals, legumes, fruits), forestry, and range.
- The RARC for the central area, located in Musrata, 200 km east of Tripoli, covers the areas from Khomes to Sirte (2 stations). Its 10 researchers are working mainly on salinity research.
- The RARC located at Sebha (700 km south of Tripoli) covers the southern area of the country (1 station); 11 researchers work in the areas of hot/dry climate and fully irrigated crops (cereals, legumes, forages, palm trees).

Land resources are adequate; the other physical resources (buildings; scientific, computer, transport, and communication equipment) are adequate in some stations; others have financial problems which affect maintenance. Many buildings need rehabilitation, and a large part of the equipment is now outdated or insufficient, especially in the remote research stations.

ARC's current financial resources, totally funded by the Government (very little self-generated income: sales of the production of the stations, services to the public, consultancies), summed up to 3 million Libyan dinars in 1997 (US\$ 8.3 million), of which 65% (US\$ 5.4 million) were for salaries/allowances, 5% for training, and 30% for operation and capital costs (OCC). The current OCC (US\$ 2.5 million) amounts to around US\$ 20,200 per scientist on duty, which is not sufficient to ensure optimal work conditions (see Section 3.3).

Research Activities and Linkages - Currently, ARC has 10 researchers in soil sciences, 3 in supplementary irrigation, 8 in the use of saline water in agriculture, 17 in cereal crops, 15 in horticulture, 5 in vegetables, 8 in food legumes, 6 in feed legumes, 5 in seaweed as animal food, 5 in tissue culture, 5 in entomology, 5 in range management, 6 in goats, 6 in animal nutrition, 3 in agricultural machinery, and 10 in agricultural economics.

A priority-setting exercise based on the analysis of the challenges facing agricultural development in the country, experience, and available information has taken place recently and has identified 17 major research projects.

<sup>1</sup> pRYs = Number of researchers on duty × 90% (percentage of the graduate staff's time devoted to AR, mentioned above).



ARC has few collaborative research projects with other NARS institutions. A number of ARC junior research staff members prepare their MS degrees at the FAs, under joint supervision of ARC senior staff and university professors. Their research topics originate from ARC research plan and priorities.

Linkages with other NARSs are very limited (IRESA and INRAT of Tunisia, ARC of Egypt), but those with regional and international institutions are satisfactory (ACSAD, AOAD, FAO, ICARDA, IFAD).

#### **The Animal Studies and Research Center (ASRC)**

**Mandate** - ASRC (headquarters in Tripoli) carries out research on camels, cattle, poultry, sheep and goats, and veterinary medicine, as well as on farming systems, animal nutrition, rangelands, socioeconomic, and wildlife. Sixty percent of the Center's mission is on applied research, 20% on teaching and training, and 20% on consultancies.

**Resources** - ASRC has 30 research scientists, 41 technicians and 42 other support staff. Out of the 30 scientists, 22 (5 PhD, 8 MSc, 9 BSc) are on duty and represent 13 pRYs and 8 researchers are on study leaves (4 preparing MS in Libya and 4 preparing MS abroad). Four other scientists (all PhD holders) are on secondment.

ASRC has three research stations (2 for camels, 1 for livestock). Its financial resources are estimated at US\$ 1.2 million, 90% of which are government-funded and 10% self-generated funds. Sixty percent of these resources are allocated to salaries and wages, 10% to training, and 30% to OCC. The OCC (US\$ 0.36 million) represents around US\$ 15,000 per scientist on duty.

**Research Activities** - Researchers are distributed as follow: 2 for camels, 6 for cattle, 6 for poultry, 9 for sheep and goats, 4 for animal nutrition, 4 for rangeland management, and 2 for wildlife. Due to a considerable shortage of researchers, laboratories and equipment, a great deal of the planned research work cannot be carried out.

#### **The Marine Biology Research Center (MBRC)**

**Mandate** - MBRC is located at Tajura, 20 km east of Tripoli. It conducts mainly applied research which focuses on freshwater and marine fishers, aquaculture fish processing and utilization, pollution, and marine environment protection. Eighty percent of the time of the researchers on duty is devoted to research and 20% to community services (mainly directed to helping small fishers).

**Resources** - MBRC has 8 research scientists on duty, who represent around 6 pRYs, 8 researchers on study leave and 6 researchers on secondment. It also has 19 technical diploma holders and 60 other support staff.

MBRC has three research stations, two located at Tajura (for aquaculture and for marine fish research) and one at Benghazi (marine fish research). Its financial resources, all funded by the Government, amount to US\$ 0.8 million (rough estimate), of which 40% go to salaries and wages, 15% to training costs, and 45% to OCC (US\$ 0.36 million, which means US\$ 45,000 per researcher on duty).

**Research Activities** - Research programs in aquaculture/freshwater fish and marine fish were identified based on priorities and challenges facing resource development and improvement. MBRC has extended relations with the Universities of Tripoli and Al-Beida through education activities. It has almost no collaborative research projects with other NARS institutions, and linkages with international institutions are confined only to IFAD and FAO through "trust fund projects."

### **2.3 The Faculties of Agricultural Sciences (FASs)**

**Overview** - The seven FASs include five faculties of agriculture (FAs, at the Universities of Tripoli, Al-Beida, Sabha, Sirte, Zentan) and two faculties of veterinary medicine (FVMs, at the Universities of Tripoli and Al-Beida). They all provide undergraduate education, and only the FAs of Tripoli and Al-Beida offer postgraduate education (MS). Teaching is their main mandate; research, extension, and consultancy activities are generally limited. According to the survey, academic staff members allocate 60% of their time to teaching and training, 20% to research, and 20% to development (extension, consultancies, community services).

The FAs are involved in sciences related to soils, water, plant and animal production, fisheries, agricultural economics, and food science; the FVMs are specialized in animal health sciences<sup>1</sup>.

**Resources** - The seven FASs have 364 permanent academic staff members, including 223 nationals (167 PhD and 56 MS) and 141 expatriates, and around 40 BS holders considered as technical staff. The total graduate staff represents

<sup>1</sup> The FA of Tripoli has 11 departments (soil and water, crop production, horticulture, range and forestry, agricultural engineering, food science, agricultural economics, home economics, plant protection, fisheries, and animal production). The FA of Al-Beida has 9 departments (animal production, agricultural economics, food sciences, soil and water, plant protection, horticulture, crops, natural resources, and agricultural extension). The FVM of Tripoli has 10 departments in different veterinary sciences.

around 101 pRy<sup>1</sup>. The old FAs (Tripoli and Al-Beida) and the FVM of Tripoli have a large body of permanent academic staff, while the new FAs in Sirte, Sebha, and Zentan are endowed with very few permanent staff members.

Almost 78% of this staff is concentrated in Tripoli and El-Beida. Technicians and support staff (laborers, clerks) are very few and involved mainly in assisting in teaching activities, particularly in labs and farms. Physical facilities (buildings, labs, equipment, computer facilities, libraries, farmland, machinery, vehicles, etc.) are generally inadequate in quantity and quality, particularly in the last 10 years (poor maintenance, no replacement).

The financial resources of the FASs are important (total estimated at US\$ 11.6 million) and are all government-funded. They are allocated mainly to salaries (around 75%); OCC amounts to about US\$ 2.9 million, i.e., less than US\$ 8,000 per academic staff member for all the training, research and development activities, which is very insufficient.

Collaboration between the FAs and FVMs of the different universities is fair and generally developing on an individual basis. Linkages with the national agricultural research and extension services seem moderate and informal. External (regional and international) relations are rather poor.

**Research Activities** - Generally, AR in the faculties suffers from a number of obstacles, mainly:

- Lack of research policy; lack of AR resources (few support staff<sup>2</sup>, very low OCC available for research);
- Due to low salaries, staff members tend to prefer consultancies and extension services to increase their income;
- Heavy teaching load for the staff members due to the high student-to-teacher ratio (25:1).

AR at the faculties is currently carried out mainly by young staff members and graduate students, with very limited direct involvement of the senior academic staff. AR activities/projects are conducted on an individual basis and not decided with reference to the national AR policy and the National Development Plan of the country.

Accordingly, the academic staff members may actually allocate only around an average of 10% of their time to AR, which means that they represent around 40 actual RYs. Financial resources allocated to AR (including salaries) may represent also roughly 10% of the total resources.

## 2.4 **The Other Institutions of the NARS<sup>3</sup>**

### **The Nuclear Research Center (NRC)**

NRC, now affiliated with the Secretariat of Training and Habilitation (STH), has in its Directorate of Applied Research an "Agriculture Section" devoted to AR activities. This Section has 17 national researchers (3 PhD, 5 MS, 9 BS) and 5 technicians working mainly in the control of spoilage and deterioration of stored fruits, and use of isotopes in producing and selecting mutant barley varieties with high yield. Current physical and financial resources are much lower than some years ago.

### **The Libyan Center for Remote Sensing and Space Sciences (LCRSSS)**

AR-related activities utilize around 30% of the resources of the Center<sup>4</sup>. They are implemented within the Department of Remote Sensing, based in Tripoli, by 15 national researchers (1 PhD, 4 MS, 10 BS), who allocate around 50% of their time to research (8 pRy) in geo-botanical mapping (3 researchers), water harvesting and water erosion studies (4 res.), land-use planning (3 res.), desertification monitoring (2 res.), and rangeland mapping (3 res.).

This Department enjoys rather good physical facilities (fully equipped with computers and software, and the necessary facilities) and financial resources. Financial resources allocated to AR roughly amounted to US\$ 0.6 million in 1998.

<sup>1</sup> Taking into account the normative rate of 25% of the academic staff members' time allocated to AR activities adopted for the analysis of all the WANA NARS (see methodology of the study).

<sup>2</sup> 0.32 technician per academic staff member.

<sup>3</sup> The Environmental Protection Research Center (EPRC, established in 1985), now affiliated with the Secretariat of Municipalities (SM), and the Solar Energy Research Center (SERC, 1989), under the Secretariat of Training and Habilitation (STH), are partly involved in AR activities, but precise information on these activities and the corresponding resources is not available.

<sup>4</sup> LCRSSS, created in 1989 and now affiliated to STH, has two other departments specialized in seismography (at Gharian) and astronomy (at Benghazi). It has 90 full-time employees (38 of whom are researchers and 33 are technicians). Its researchers allocate around 50% of their time to research and 50% to consultancies and training. Its budget, funded totally by the Government, amounted to US\$ 2 million in 1997; 50% allocated to salaries and 50% to OCC.

### **The Economic Studies Research Center (ESRC)**

ESRC, based at Benghazi, is affiliated with the National Authority for Scientific Research. Among its 17 graduate staff members involved in research and studies on economic policies, 7 scientists are specialized in agricultural economics and work in cooperation with the Faculty of Economics of Gar Yunis University of El-Beida.

## **3. AR RESOURCES**

### **3.1 Human Resources** (see Table 1)

The NARS employs around 620 scientists (including 141 foreigners), 29% of whom are employed at the AR institutes, 65% at the FASs, and 6% at the other scientific institutions. This scientific potential is highly concentrated around Tripoli (80%). It currently represents around 264 pRYs, without taking into account the scientists on study leave and on secondment, who are numerous at the AR institutes.

These scientists have a rather sound academic background especially at the FASs, which benefit from a higher proportion of PhD holders than at the AR institutes. However, strong efforts are being undertaken at these institutes to improve the qualification of their researchers.

ARC is the only NARS institution which employs a relatively good number of technicians (1.9 per researcher). ASRC and MRBRC are less endowed (1.3 and 0.9 technician per researcher, respectively). The FASs are facing a severe deficit. A similar situation is observed in terms of the other support staff (laborers/ clerks).

All wages and salaries in the Government follow one scale, with no private-sector equivalent in the country. The other incentives come mainly from extra academic teaching loads and supervision of graduate students (at the universities). Incentives at the other AR institutions come mainly from research allowances.

### **3.2 Physical Resources**

Land resources (research stations and farms) of the institutions cover most of the agroecological zones (northwestern, central, eastern and southern zones) and are certainly adequate (2,000 ha). The other physical resources (offices, farm buildings, labs, computers, transport, communication equipment) are insufficient and poorly maintained. The libraries of ARC, MBRC, and the FASs are satisfactory, although they lack up-to-date documents and some communication facilities (e-mail and Internet).

### **3.3 Financial Resources** (see Table 1)

The total budget for AR was estimated at US\$ 13.1 in 1997, all coming from national sources, mainly from the state budget. Such resources represent around 0.67% of the AGDP (US\$ 2 billion in 1996/97), which is rather low for a country which is one of the richest in the WANA region and where food imports amount to around 50% of the AGDP.

Areas of expenditure vary considerably between the institutions. As seen above, OCC for AR per scientist are good at MBRC and LCRSSS, but are insufficient in most of the other NARS institutions. The corresponding OCC per pRY<sup>1</sup> (around US\$ 21,000 at ARC, 17,000 at ASRC, and certainly less than 3,000 at the FASs) is well under the "optimal" amount of US\$ 25,000–30,000 per RY used in the long-term plans drawn up by many countries in similar agroecological conditions. According to this last reference, the ratio of actual employment in AR of the scientists should amount to around 75% at ARC, 60% at ASRC, and 10% at the FASs. Therefore, the NARS has around 160 actual RYs (aRYs) (84 at ARC, 8 at ASRC, 6 at MBRC, 40 at the FASs, and 22 at the other institutions) instead of the 264 pRYs estimated above.

Regarding the allocation of these resources, it is worth mentioning the high percentage allocated to training activities at the AR institutes.

<sup>1</sup> As the numbers of pRYs are lower than the numbers of graduate staff members (and part of the OCC is allocated to other activities than research), OCC per pRY is higher than OCC per staff member.

## 4. RESEARCH ACTIVITIES

### 4.1 Research Orientation and National Linkages

The research agendas for ARC, MBRC and ASRC are, to a large extent, oriented according to the development plan of the country, and also according to medium-term research plans set by these institutions. AR at the FASs is largely developed on an individual basis.

Cooperation between the AR institutions themselves and between the AR institutes and universities is informal, unsatisfactory, and does not follow a clear pattern. However, there is some sort of cooperation between research institutes and universities, mainly through MS training of young researchers of the AR institutes.

To a large extent, AR in Libya plays a considerable role in adapting technologies to meet the needs of agricultural development. The research work plans are designed mainly to overcome challenges and bottlenecks facing the agricultural sector in the country.

### 4.2 International Relations

Most of the NARS institutions have very poor relations with international scientific institutes and funding organizations. ARC is an exception, with its moderate linkages with ICARDA, CIMMYT, ACSAD, CIHEAM, FAO, IFAD, AOAD, and UNDP, which supply ARC with some needed external knowledge and resources (such as germplasm), and provide appreciable collaboration in research and backstopping.

## 5. CONCLUSION

The AR institutes have attempted to set up research programs and undertake recruitment and training efforts in accordance with the country's agricultural potential and development plans. However, their strategy is hampered by:

- The limited collaboration with the FASs and other scientific institutes; active complementarity should be ensured for a better use of the national resources.
- The insufficient and unsustainable financial resources, particularly for operation and capital costs, which are not adequate to provide the needed spare parts, maintenance, new equipment and instruments.
- The lack of technicians and support staff.
- The restricted bilateral and international cooperation at present with other NARSs and organizations, indispensable for strengthening the national scientific capacity.

### Main Acronyms

SA: Secretariat (Sec.) of Agriculture. SAAW: Sec. of Agriculture and Animal Wealth. SAW: Sec. of Animal Wealth. SESR: Sec. of Education and Scientific Research. SMW: Sec. of Marine Wealth. SM: Sec. of Municipality. STII: Sec. of Training and Habilitation. NASR: National Authority for Scientific Research.

ARC: Agricultural Research Center. ASRC: Animal Studies and Research Center. MBRC: Marine Biology Research Center. ESRC: Economic Studies Research Center. LCRSSS: Libyan Center for Remote Sensing and Space Science. NRC: Nuclear Research Center.

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**Table 1 - The National Agricultural Research System (1998)**
*Notes:* Approximate data. % Rounded numbers. ... Data not available. \* See footnotes.

NARS Institutions				Scientific & Technical Graduate Staff (Units)				Potential Research Years *			Total Budget*	AR Expend./Res.*	
No.	Name - Acronym Head Office - Year Established	Mandates AR Fields	Gover. Minist.	Nationals Total - (Ph.D., MS)		Exp.	Total	Nat.	Ext.	Total	(US\$ million)	(US\$ million)	
a	b	c	d	e	f	g	h	i	j	k	l	m	
1.1	Agricultural Research Center, Tripoli	ARC - 1971	SA	133*	10, 34	0	133	112		112	8.3	7.9	
2.1	Animal Studies and Research Center, Tripoli	ASRC - 1996	SAW	30*	5, 8	0	30	13		13	1.2	1*	
2.2	Marine Biology Research Center, Tripoli	MBRC - 1969	SMW	16*	2, 4	0	16	5		5	0.8	0.7	
1/2	Total AR Institutes			179	17, 46	0	179	131		131	10.3	9.6	
3.1	Fac. of Ag., Un. El-Fateh, Tripoli	1966	AHE - (AR) - All*	SESR	...	134	12	...	66	35	101	11.6	1.2
3.2	Fac. of Ag., Un. Omar El Muhlar, El Beida	1975	AHE - (AR) - All*		...	52	34	...					
3.3	Fac. of Ag., Un. Atahadi, Sirte	1992	AHE - (AR) - All*		...	2	5	...					
3.4	Fac. of Ag., Un. Sabha, Sabha	1978	AHE - (AR) - All*		...	2	14	...					
3.5	Fac. of Vet. Medicine, Un. El-Fateh, Tripoli	1975	AHE - (AR) - Anim. health		...	21	30	...					
3.6	Fac. of Vet. Med., Un. Omar El Mnh., El Beida	1988	AHE - (AR) - Anim. health		...	2	26	...					
3.7	Fac. of Vet. Med. & Ruminant Ag., Un.*, Zentan	1997	AHE - (AR) - All		...	4	20	...					
3	Total Agricultural Sciences Faculties			263*	167, 56	141	404	66	35	101	11.6	1.2	
4.1	Ag. Section, Nuclear Research Center, Tajoura*	NCR - 1976	STH	17	3, 5		17	17		17	1.2	1.2	
4.2	Depart. for Remote Sensing, LCRSS, Benghazi*	LCRSS - 1990	STH	15	1, 4		15	8		8	0.6	0.6	
4.3	Ag. Section, Econ. Studies Res. Center, Tripoli*	ESRC - 1985	SESR	7	1, 2		7	7		7	0.5	0.5	
4	Total Other Scientific Institutions			39	5, 11	0	39	32		32	2.3	2.3	
5	Total NARS (approximate)			481	189, 113	141	622	229	35	264	24.2	13.1	
Exchange Rate: 1 Libyan dinar = US\$ 2.77 (1998 average official rate)							Actual Research Years (aRYs) (Estimate) →			160			

SA: Secretariat of Agriculture, SAW: Sec. of Animal Wealth, SMW: Sec. of Marine Wealth, SESR: Sec. of Education and Scientific Research, SM: Sec. of Municipalities, STH: Sec. of Training and Habilitation, NARS: National Authority for Scientific Research.

**e Mandates:** AR (%): Approximate average % of human resources devoted to ag. research (AR); R: Research; AHE: Ag. higher education; AD: Ag. development/services (for AR and AHE institutes: seed production, soil and water analysis, extension, studies, etc.). **1, 1, k** Potential research year (pRY) = equivalent full-time researcher; for the FASs, the pRYs have been estimated by multiplying the number of academic staff by 0.25 for the AR institutes. AR financial resources were roughly estimated through the following formula: Total budget × [(w + 0.5(100% - w))], where w is the % of time devoted to AR by the graduate staff.

\* Notes: **1, m** All financial resources are national. **1.1:** ARC: including 9 graduate staff members on study leave (5 MS and 4 BS). **2.1:** ASRC: including 8 graduate staff members on study leave (4 MS and 4 BS). **2.2:** MBRC: including 8 researchers on study leave. **3.7:** The FASs employ 263 national academic staff members, including 223 PhD and MS holders and around 40 BS holders who are considered as technicians. **4.1 to 4.3** Only the graduate staff and financial resources allocated to AR are mentioned.

National Total AR expenditures (NE/TE): 0.67% of the Agricultural Gross Domestic Product (AGDP): US\$ 2 billion in 1996/97).

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF MOROCCO<sup>1</sup>

## I. HISTORICAL BACKGROUND

The first formal agricultural research (AR) related activities in Morocco were conducted by the *Jardin d'Essais* (Botanical Garden) of Rabat established in 1919 by the French colonial authorities. This unit served throughout the years (until today) as headquarters for the *Service de l'Expérimentation Agricole* (1924), the *Centre de Recherche Agronomique* (1934), and the *Service de la Recherche Agronomique et de l'Expérimentation Agricole* (SRAE, 1946). All these institutions enlarged their AR activities through an increasing number of scientific departments and experimental stations spread throughout the country. Among the other colonial initiatives related with agricultural sciences, there were:

- the *Service de l'Expérimentation Forestière* (1934), which is the first antecedent of the current National Center for Forestry Research (CNRF: *Centre National de la Recherche Forestière*);
- the Agricultural School of Meknès (1940), created mainly to train sons of French farmers at the BS level;
- the Scientific Institute for Marine Fisheries (1947), renamed later (1969) "*Institut Scientifique des Pêches Maritimes*," then (1996), "National Halieutic Research Institute" (INRH: *Institut National de Recherche Halieutique*); and
- the *Centre des Expérimentations* (1952), created for supporting the design and operation of the large irrigation schemes launched afterwards in the country, which became later the Service for Experimentation, Testing and Normalization (SEEN: *Service d'Expérimentation, d'Essais et de Normalisation*).

After independence (1956), SRAE absorbed (in 1957) some existing national services affiliated to the new Ministry of Agriculture (mainly the Service for Plant Protection and the laboratories responsible for plant/food analysis). From 1959 to 1961, SRAE and the agricultural higher and technical schools were affiliated to a unique service responsible for agricultural research and education. In 1962, the National Agricultural Research Institute (INRA: *Institut National de la Recherche Agronomique*) was established as an autonomous institution under the Ministry of Agriculture and Agrarian Reform (MARA), and its director remained for some years Director of Agricultural Education. In 1966, INRA became the *Direction de la Recherche Agronomique* (DRA) within the largely reorganized MARA.

That same year, the Agronomic Institute was established at Rabat as a new agricultural higher education (AHE) institution; in 1971 it became the Hassan II Institute of Agronomy and Veterinary Medicine (IAV: *Institut Agronomique et Vétérinaire Hassan II*). This Institute has taken advantage of the stability of its management (two directors in 30 years) and scientific staff for growing and enlarging its mandate (horticulture section opened at Agadir; halieutic sciences; food technology; etc.) with strong external support (132 expatriates in 1978), mainly from France and the USA. The National Forestry School, Salé (ENFI: *Ecole Nationale Forestière d'Ingénieurs*) was created in 1968.

In 1980, DRA again became INRA, a MARA autonomous institution. After this new start, INRA undertook progressive and large renovation with strong external support (mainly a huge 10-year USAID grant and then a World Bank loan); it concentrated on AR activities, transferred its plant protection and technical control services to a new MARA directorate and its seed production to a public enterprise, created regional centers, reduced the excessively large number of stations, developed postgraduate training for its staff, and recruited numerous new scientists.

In 1993, MARA established the Directorate for Agricultural Training, Research and Development (DERD: *Direction de l'Enseignement Agricole, de la Recherche et du Développement*) for overseeing and coordinating the MARA units involved in these three fields.

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## 2. THE CURRENT NARS

### 2.1 Overview (see Table 1)

The Moroccan NARS currently consists of three main sets of public institutions:

- Four AR institutions: the National Agricultural Research Institute (INRA); the National Center for Forestry Research (CNRF); the Service for Experimentation, Testing and Normalization (SEEN); and the National Halieutic Research Institute (INRH); together they account for 64% of the total potential research years (pRYs: equivalent full-time researchers) and 63% of the financial resources of the NARS. These institutions are presented in Section 2.2.
- Three agricultural higher education (AHE) institutions: the Hassan II Institute of Agronomy and Veterinary Medicine of Rabat and Agadir; the National Agricultural School (ENA), Meknès; and the National Forestry School (ENFI), Salé, which account for 18% of the pRYs and 12% of the total financial resources of the NARS (see Section 2.3).
- A few other scientific and technical institutions which allocate significant resources to AR (around 18% of the pRYs and 25% of the total financial resources of the NARS) (see Section 2.4).

The AR and AHE institutions and most of the other NARS institutions are affiliated to the new Ministry of Agriculture, Rural Development, and Marine Fisheries (MADRPM: *Ministère de l'Agriculture, du Développement Rural et des Pêches Maritimes*). DERD is officially responsible for overseeing and coordinating the MADRPM units involved in training, research and development, especially at the regional level, and for accelerating technology transfer through stronger linkages between scientific institutions and the public and private development/extension organizations; but it has few resources and limited authority on the national AR policy. The National Center for Coordination and Planning of Scientific and Technical Research (CNCPRST), affiliated with the Ministry of Higher Education and Scientific Research (MESRS), is mandated with defining, implementing, and evaluating the overall national research policy, with little direct involvement in the AR sector.

Private AR activities are limited. They are implemented mainly by the *Domaines Agricoles* (previously called the *Domaines Royaux* or King Estates)<sup>1</sup> and by some foreign agro-industrial companies<sup>2</sup>, which operate alone or in collaboration with the public NARS institutions.

### 2.2 The Agricultural Research Institutes

#### The National Agricultural Research Institute (INRA)

Mandate and Organization - INRA is the major NARS institution (45% of the pRYs and of the total financial resources of the NARS). It is a public autonomous institution headed by a Director who reports to the Minister of Agriculture and to a Board chaired by the Minister of Agriculture, which includes representatives of the Ministries of Finance, Education, Health, and the Interior, and of the farming sector.

Its main mission is AR, which mobilizes around 90% of the time of its senior staff and covers all fields (crops, livestock, food technology, etc.), except forestry, irrigation technology and fisheries. Research is mainly applied and adaptive (80%). Other activities cover transfer of technologies (through its *Service de Recherche et Développement*), and education (support to graduate students' theses, lectures at several universities, etc.).

INRA headquarters are in Rabat. Its seven departments (natural resources, plant breeding, plant protection, agronomy, livestock, food technology, and socioeconomic) and eight regional centers (see below) contribute to the implementation of 16 programs on commodities (cereals, food legumes, forage, etc.), farming systems (arido-culture, Saharan agronomy, etc.), and disciplines (socioeconomics, farm machinery, food technology, etc.).

<sup>1</sup> These *Domaines Agricoles* have highly advanced research laboratories in biotechnology and tissue culture (Selouane Laboratory, Meknès; Agronomic Laboratory of El Boura, Agadir; etc.), which collaborate closely with INRA, IAV Hassan II and ENA, and with advanced laboratories in Europe and the USA. They play a leadership role in agricultural development and technology adoption.

<sup>2</sup> Such as Pioneer and Tazier, which conduct applied research on various crops (cereals, vegetables) to test their performance and pest resistance before release to farmers.



**Human, Physical and Financial Resources** - Currently (1997), INRA has 1,800 employees, of whom 300 are professional graduate staff members, including 282 nationals (50 PhD, 196 MS and 36 BS holders)<sup>1</sup> and 18 expatriates, who represent a total of 270 pRYS<sup>2</sup>. National research staff members are generally young. Until 1996, national graduate staff joined INRA according to one of two categories: (i) the new scientific status, chosen by about 20% of the members, which is equivalent to university scientists, with advancement in their careers subject to the assessment of their scientific results; or (ii) the technical status, equivalent to ministry organizations with slightly lower salaries.

The regionalization policy implemented by INRA during the last 20 years has reduced the concentration of graduate staff at Rabat (34% now, compared to 40% previously) and reinforced some regional centers, mainly Settat (19%), Meknès (15%) and Marrakech (11%). However, the other centers remain much understaffed.

INRA has 354 technicians, many of whom are assigned to administrative positions, which makes the current average number (1.1) of technicians per graduate staff member very insufficient and should be better distributed among the regional centers. Moreover, INRA has maintained a large body of support staff (1,150 clerks, secretaries and laborers), which fits with the usual norm.

The eight regional research centers and 24 experiment stations (total: 4,800 ha) are spread across the country. The regional centers host more than 90% of the 109 laboratories. Experiment stations are devoted mainly to research (some seed and crop production). Some recently established or renovated centers (Settat, Marrakech, Tangiers, Meknès) enjoy good physical resources, but laboratory equipment and farm machinery suffer insufficient maintenance and repair. Considerable investments have been made in the last years to strengthen the division of information and documentation and the central library of Rabat<sup>3</sup> (recruitment of qualified librarians, new equipment, linkages with the other national documentation centers and international databases, etc.).

The 1996 INRA total financial resources amounted to Dh 166 million (Dh: dirham) (US\$ 18.9 million), of which Dh 134 million came from national sources (mainly from the government budget, and about 10 million from self-earned funds: research contracts, royalties, sales of seeds, analysis, etc.), Dh 26 million from a World Bank loan, and Dh 6 million<sup>4</sup> from grants offered by donors (Germany, France, USA, etc.) through the 18 expatriates and collaborative research programs. National salaries absorbed Dh 94 million, and operation and capital costs (OCC) some Dh 69 million—almost fully allocated to research activities—amounting to around Dh 260,000 (US\$ 29,000) per pRY. Until 1994, the year of completion of the 10-year USAID project, OCC per pRY has been much higher due to the large USAID financial assistance, partly replaced by the World Bank loan (in 1994, the operation/capital budget directly allocated to researchers was two times higher than in 1996). Procedures for financial transactions related to the national budget and the World Bank loan are lengthy and payments are delayed.

**Research Activities and Linkages** - With ISNAR support, INRA has developed in the last 10 years a "programming by objectives" (PBO) system based on consultations between INRA and researchers, farmers, and extension agents, and assessment of market demand. Evaluation of research programs is made through different bodies, mainly a scientific committee (composed of INRA leaders and high-level scientists from IAV Hassan II and ENA) and sectorial committees (which include representatives of the agro-food associations). All these mechanisms have reinforced the multidisciplinary approach, allowed better use of human and financial resources, and improved linkages with development organizations and other NARS institutions.

However, the PBO system has not been totally finalized because human and financial resources have not been available according to the system's needs. Some high-priority research areas, such as cereals, food legumes, IPM, plant nutrition and management, soil/water management and conservation, forage/pasture and sheep, are rather well covered, but many cross-sectorial research areas are understaffed, mainly horticultural crops, industrial crops, rangelands, farming systems, socioeconomics, biotechnology and food processing.

INRA's results are published in "*Al Awamia*," a quarterly scientific journal, and technical bulletins. Based on these results, about 65 of INRA's cultivars of various cereals, forages and food legumes are marketed by the National Seeds Marketing Society (SONACOS).

<sup>1</sup> Due to its successive reorganization and changes in mandate, INRA lost a large number of national professional staff from 1980 (259) to 1989 (171). Then, the number and academic level of this staff steadily increased, with a high turnover of senior research staff due to salaries lower than at the academic institutions.

<sup>2</sup> 300 professional graduate staff members  $\times$  90% (the percentage of their time allocated to AR).

<sup>3</sup> This library contains about 30,000 books, 21,000 reports and 1,400 periodicals.

<sup>4</sup> This amount includes the cost of the 18 foreign researchers estimated at the "national cost" (average cost of national researcher with same qualifications/experience).

For improving its research programming and dissemination of research results, INRA has strengthened its linkages with development organizations through numerous channels:

- PBO (presented above), which has adapted research priorities according to farmers' needs;
- specific research contracts with regional integrated projects;
- preparation of information packages for extension services and farmers; this is the main task of the Research and Development (R&D) Units created in each regional center;
- demonstration experiments in farmers' fields set up and evaluated jointly with extension agents and farmers on a large scale throughout the country (500 to 2,000 farmers participate annually);
- several sectorial committees set up both at the national and regional levels (National Cereals Development Committee, National and Regional Citrus Committees, National Soya Committee, National Colza Committee) which bring together representatives of the research profession, and training and development institutions; and
- field days in experimental stations, commodity- or discipline-oriented workshops, training courses, on-the-job training, etc.

INRA has good linkages with ENA, Meknès (its regional center of Meknès is on ENA campus), IAV, and some universities (Marrakech, Meknès, Settat). Many academic staff members participate in its research programs in order to provide some methodological and scientific support, and train young researchers. Relations with the other NARS institutions are rather limited.

Scientific relations with AR international centers (CIMMYT, CIP, ICARDA, ISNAR), regional organizations (ACSAD, CIHEAM), and with scientific institutions from developed countries (European Union, France, Germany, Italy, USA) are also well developed. INRA is also a member of AARINENA.

### **The National Center for Forestry Research (CNRF)**

CNRF's mission is mainly research (90% of its graduates' time) on forestry, wildlife, and land erosion.

Resources - CNRF employs 37 researchers, including 36 nationals (1 PhD and 35 MS holders), who follow the same salary scale and career scheme as public servants, and 25 technicians (0.7 per scientist). It has its main laboratories at Rabat in addition to eight experiment stations. The total 1996 financial resources amounted to Dh 17 million (US\$ 1.9 million) provided by the Government, of which only Dh 1.4 million was devoted to OCC (about US\$ 4,200 per pRY).

Research Activities and Linkages - Priority research areas are natural and plantation forests (14 researchers), wood processing and utilization (4 res.), and wildlife (5 res.). These research areas are supported by researchers in land/water management, agrometeorology, integrated pest management, biotechnology, rangelands, socioeconomic, and biometrics. Sixty-five percent of the resources are devoted to applied/adaptive research, 25% to basic research, and 15% to on-farm research.

There is no evaluation of research or researchers. Research outreach is very weak, since the allocated human and financial resources are insufficient. CNRF publishes a scientific journal, *"Annales de la Recherche Forestière."* It disseminates research results through field days, seminars and technical bulletins.

With the reorganization of the forestry services, CNRF will have to work more closely with the forestry extension agencies (CDFs: Centers for Development of Forestry) that are spread across Morocco. CNRF has little interaction with the international scientific community (joint research programs and scientific exchanges with four international institutions, including membership of the International Union of Forestry Research organization, IUFRO).

### **The Service for Experimentation, Testing and Normalization (SEEN)**

SEEN is under the MADPRM Directorate of Rural Engineering (AGR). Its main mandate (80% of the time of its graduate staff) is on applied and adaptive research on land and water and agricultural engineering (hydraulics).

Resources - SEEN has 17 graduate staff members (4 PhD, 12 MS and 1 BS holders), who follow the same salary scale and career scheme as public servants, and 50 technicians. Laboratories are located mainly in Rabat; SEEN uses nine regional experimental stations belonging to irrigation bureaus. In 1996, financial resources, almost fully provided by the Government, amounted to Dh 7 million (US\$ 0.8 million). Dh 1.2 million is allocated to OCC (about Dh 86,000 or \$ 9,700 per pRY).

Research Activities and Linkages - Research domains cover mainly soil and water management and conservation in irrigated areas, agricultural engineering, agrometeorology, and laboratory testing of irrigation technologies. Even though it does not have a specific scientific journal, SEEN disseminates its results through technical bulletins,

seminars, technical meetings, and a pilot farm for training extension agents in irrigation techniques in order to upgrade the human resource capabilities of the nine irrigation "offices" (that cover 1 million ha of irrigated land). It has few international linkages.

SEEN is managed and viewed as a regular public-service-oriented institution, with a classical administrative structure and management, and not as a research institution.

### **The National Halieutic Research Institute (INRH)**

Mandate and Organization - INRH, an autonomous institute affiliated to MADRPM, is governed by a Board of Directors and led by a Director General and a Secretary General. It has five departments: Halieutic, Marine Environment (Quality and Salubrity), Oceanography, Economy and Fishing Technology, and Finance and Administration; however, this organization is under deep restructuring to achieve decentralization that is more appropriate for covering scientific marine research along an extended coastline (about 3500 km). INRH is the major fisheries research body in Morocco; its graduate staff allocate around 70% of their time to research and 30% to other activities (public analysis/surveys, extension support to the profession, etc.).

Human, Physical and Financial Resources - INRH currently has 99 scientific and technical graduate staff members (10 PhD, 42 MS and 47 BS, including 15 applying for MS: 14 in Morocco and 1 in Canada), supported by 81 technicians, 26 unskilled staff (drivers and others), and a crew (2 captains with an MS-equivalent degree and 20 seamen). High-level staff members for management are insufficient. A proposal for a specific statute for researchers will be soon submitted to the Government for approval.

Physical resources are rather good and have been improving over the last years. The central laboratories of INRH are located in Casablanca. It also has a network, that is well distributed along the coastline, of 5 regional research centers<sup>1</sup>, 6 stations for monitoring the salubrity of the littoral, and 6 sampling stations (for carrying out sampling on a regular basis of commercial landings and for collecting bio-statistical data). INRH owns a large research vessel acquired in 1986 within the framework of Moroccan-Japanese cooperation, equipped with modern facilities for carrying out oceanographic and sedimentologic studies.

Within the last decade, the budget allocated to research has undergone substantial growth, especially with the decentralization of research through the establishment of regional centers. In 1998, national financial resources, almost fully provided by the Government, amounted to Dh 48 million (US\$ 5.4 million), of which Dh 17 million were for salaries and Dh 31 million for OCC (about US 35,000 per graduate staff member), which appears to be a sufficient amount for covering INRH research and service mandates. The 1999 budget amounts to Dh 60 million. External resources are limited.

Research Activities and Linkages - INRH has four principal missions: (i) stock assessment and fisheries management (biology and ecology of the main species of high commercial value, stock population dynamics, fisheries management plans through bio-economic models and simulation of scenarios, etc.); (ii) quality/salubrity dynamics of the marine environment (assessment and permanent monitoring in the fields of bacteriology, chemistry and toxicology; salubrity of sea products; etc.); (iii) research and experimentation in marine technologies (new fishing gear, traditional fishing vessels, fish preservation, etc.); and (iv) economics and valorization of sea products (socioeconomic studies of the various fishing and aquaculture products and the transformed ones).

Research results are published in INRH publications: *Travaux et Documents* and *Note d'Information*. Documentation is now under reorganization for improving the efficiency of the process.

Scientific cooperation is fruitful, mainly with France, Japan, Spain, and Portugal.

## **2.3 The Agricultural Higher Education Institutions**

### **The Hassan II Institute of Agronomy and Veterinary Medicine (IAV)**

Mandate and Organization - IAV is the most important national academic institution. Thirty percent of its academic staff's time is allocated to training, 30% to research, 20% to services (consultancies, studies, etc.<sup>2</sup>), and 20% to study leaves and administration. It offers MS and PhD education covering all fields, including veterinary sciences, seafood

<sup>1</sup> Two (Nador, Tangier) along the Mediterranean seacoast and three (Dakhla, Laayoune, Agadir) along the coast of the Atlantic Ocean; the Centers of Nador and Agadir are about to start their activities.

<sup>2</sup> Soil and water analysis for farmers and the private sector (annual capacity: 3,000 soil samples and 4,000 water samples); plant and animal disease diagnosis and recommendations for control, etc.

sciences, rural agricultural engineering (irrigation<sup>1</sup>, mechanization), and food technology. Around 1,200 students are enrolled (including about 10% from French-speaking sub-Saharan countries), which means a fair ratio of 4 students per academic staff member, one of the best in the WANA region.

**Human, Physical and Financial Resources** - IAV employs 1100 staff members, including 132 technicians, 625 other support staff (clerks, laborers), and 317 academic staff members (315 nationals: 194 PhD, 113 MS and 8 BS holders; 2 expatriates), of whom 91 are in the agronomy section, 65 in the veterinary medicine section, and 35 to 37 in each of the food technology, rural development, horticulture and basic sciences sections.

IAV has large, modern facilities (lecture rooms, labs, a central library, etc.) on two campuses (Rabat and Agadir) and three experimental farms/stations (total: 655 ha) serving for both research and teaching purposes. Equipment is reasonably satisfactory, but limited funds are available for maintenance and replacement.

The 1996 total financial resources are estimated at Dh 164 million (US\$ 18.6 million), of which:

- Dh 156 million came from national sources, mainly from the Government (80% for salaries; 20% for OCC, of which 20% are allocated to AR activities), and from research contracts with public and private organizations (MADRPM Departments of Plant Production and Animal Production, commodity associations, food industries, etc.); and
- Dh 8 million from external grants, mainly obtained through research contracts with bilateral and international organizations (FAO, WHO, UNDP, EU, IFS, etc.), including some contracts related to research/studies conducted in other African countries (Guinea, Mauritania, Mali and Chad).

Total funds allocated to AR at IAV are roughly estimated at Dh 38 million (US\$ 4.3 million), coming from national (Dh 35 million) and external sources (Dh 3 million), of which Dh 26 million are devoted to staff salaries and Dh 12 million to OCC<sup>2</sup>. This OCC deserves two comments: (i) OCC per scientist per year is Dh 38,000 or US\$ 4,300, and may allow the academic staff to dedicate only, as an average, around 15 to 20% of its time to AR activities; and (ii) the Dh 12 million OCC is funded mainly through research contracts and research grants (Dh 8.3 million, of which 3 are from external sources), and 3.7 million from the government allocation.

**Research Activities and Linkages** - IAV has no research policy; most of its research programs are initiated upon request and through funding from the national public and private sectors or from international institutions. They aim to solve short-/medium-term problems related to agricultural development, without sufficient continuity. However, IAV's research activities have resulted in the introduction of many improved agricultural practices leading to increased yields (through breeding, agronomy, IPM, etc.) for citrus, potato, vegetables, sugar beet, etc. Tropical crops, such as banana, pineapple and mango, were introduced and adapted to the ecological conditions of the country.

The IAV publishing center, *Actes Editions*, is very active; it publishes books, a Newsletter, a magazine, and two scientific journals (*Les Actes de l'Institut Agronomique et Vétérinaire Hassan II* and *Hommes, Terre et Eaux*). Papers are also published in other national or international journals. Moreover, all completed projects necessarily end with a written report, and every year, IAV produces about 350 MS theses and 10 to 20 PhDs.

Relations with national development organizations are established through research/study contracts, services (soil and water analysis, etc.), soil mapping, direct technical assistance, and many professional associations set up by the Institute<sup>3</sup>. IAV is involved in numerous regional and international networks (camels, legumes, goats, range management, date palm) and collaborative research programs with scientific institutions from developed countries (USA: University of Minnesota, Utah State University, and others; France; Belgium; etc.) and with regional and international organizations (ICARDA, CIEHAM).

<sup>1</sup> The International Irrigation Center (IIC), established by IAV in 1985, offers both national and international training (MS-level training) and short courses in diverse fields (management of large-scale irrigation projects, on-farm water management, etc.).

<sup>2</sup> Data for the year 1993/94.

<sup>3</sup> Such as the National Associations for land consolidation, irrigation and drainage (ANAFID); plant production, protection and plant breeding (ANAPPV); animal production (ANPA); soil sciences (AMSSOL); nutrition (SMN); etc.

## The National Agricultural School of Meknès (ENA-Meknès)

ENA's mission covers education, research (15% of its academic staff's time) and development/services<sup>1</sup>. It offers MS education (6 years beyond high school education or *baccalauréat*), with specialization in plant production, plant protection, animal production, agricultural economics, agricultural extension and agricultural education.

**Resources** - The total number of staff is 269, including 93 academic staff members (88 nationals: 39 PhD, 44 MS and 5 BS holders; 5 expatriates) and 46 technicians. ENA enjoys good physical facilities; its buildings are located on a farm of 600 ha (staffed by 5 graduates and 3 technicians), which serves research, training and production objectives. Its total financial resources amount to Dh 37 million (US\$ 4.2 million), of which Dh 35 and 2 million come from national and external sources, respectively.

**Research Activities and Linkages** - Research funding and programs have the same characteristics as those of IAV. AR funds may amount to around Dh 3 million, and OCC is mainly provided by research contracts (private sector, public and international cooperating agencies: GTZ, UNDP, USAID, France, FAO, etc.), and remain far below the needs. Programs are initiated by academic members according to the national and external funds available and aim to solve short-/medium-term problems related to agricultural development (especially of the Middle Atlas region), without sufficient continuity.

Dissemination of research output is through publications, such as scientific papers, pamphlets, books, and the ENA research bulletin; organization of and participation in seminars and workshops; training of extension agents; field days and outreach programs; and audiovisual programs.

Transfer of technologies is achieved through on-farm trials, field days, demonstrations, and workshops. Relations are maintained with professional organizations. ENA enjoys good relations with INRA (the INRA regional center of Meknès is located on the campus of the school) and IAV (which contributes to some teaching programs at ENA). ENA academic staff members are active in national associations for research and development (ANAPPAV, ANPA and AMSSOL); they participate in research networks in the framework of international projects supported by UNDP, ICARDA, CIHEAM, EU, INRA-France, etc.

## The National Forestry School of Salé (ENFI-Salé)<sup>2</sup>

ENFI has been offering MS education since 1992 (BS from 1970 to 1989), covering ecology, forest management, range and watershed management, forest economics, and technology and forest equipment. More than 40% of its students come from other African countries, particularly Tunisia, Algeria and Mauritania.

It has 27 national academic staff members (15 with PhD degrees) and 3 expatriates. Its total budget amounts to Dh 11 million (US\$ 1.3 million), of which 10 come from the Government budget and 1 from external sources.

Its research activities cover all the Maghreb forest areas and the associated economic sectors; however, research budget is insignificant.

## Research Activities of the Agricultural Higher Education Institutions

The availability of numerous highly qualified and experienced academic staff (430 nationals, including 248 PhD and 168 MS holders; and 10 expatriates) and numerous postgraduate students represents large comparative advantages for the three AHE institutions for implementing AR activities.

However, AR is constrained by the lack of technicians, who are scarce at IAV and ENA and mobilized mainly for education activities, and by the very limited funds for AR operation and capital expenses. For IAV and ENA, these funds come only from their government budgets and amount to around one-third of their AR OCC. ENFI does not allocate any public fund for AR. Thus, as main results:

- AR projects rely mainly on short-/medium-term funds (OCC) provided by research contracts and grants, which lack continuity, and are not based on a clear and well-defined research policy. This situation reveals (or has as a consequence) the absence of AR policy in the AHE institutions, and may explain the absence of recognition of

<sup>1</sup> ENA has four service units: the National Center for Studies and Research in Extension (CNERV), which produces audiovisual material and implements research in extension; the Center of Experimentation and Application of Agricultural Machinery (CEAMA), developed in cooperation with GTZ; *Ferticonseil*, for diagnosis and recommendations on soil fertilization for the private sector; and a phytopathology unit for pest and disease diagnosis and recommendations for the private sector.

<sup>2</sup> ENFI will move soon to Ifrane in the central mountainous zone of the country.

the three AHE institutions as an integral part of the NARS and their difficult position with respect to collaborative research because of the disparity in available resources compared with INRA.

- The total OCC available is not sufficient for meeting the research needs; scientific and other equipment (vehicles, farm machinery, etc.) cannot be repaired, replaced or modernized; and infrastructure (buildings, labs) lacks maintenance. Therefore, the AHE institutions' scientific potential is far from being well mobilized. As noted earlier, IAV academic staff may be actually devoting 20% of its time to AR activities; this rate is probably less than 10% for ENA staff, and almost nil for ENFI staff; accordingly, the three AHE institutions may account for about 70 actual research years.

## 2.4 The Other NARS Institutions

Other various public and professional scientific and technical institutions carry out AR activities, which generally cover a more or less small part of their mandate.

### The Other NARS Scientific Institutions

Some universities have units and/or highly qualified staff specialized in agriculture-related sciences such as plant/animal biology (including breeding, pathology, entomology, microbiology), food technology, rural socioeconomics, rural geography, nutrition, etc. This is the case of the University of El-Jadida (Department of Biology of the Faculty of sciences of El-Jadida and Department of Applied and Food Biology of the Faculty of Sciences of Serrat), the University of Marrakech (Departments of Biology of the Faculty of Sciences of Marrakech and of the Faculty of Sciences and Technology of Beni Mellal), the Faculties of Economics in almost all the universities, etc. Some of these units (in Marrakech, Meknès, Serrat) currently have collaborative research activities with INRA and ENA.

As a recent, complete inventory of these units is not available, it is difficult to have a precise estimate of the total number of academic staff members concerned. Nevertheless, through a quick survey of some universities (Marrakech, Meknès, Serrat, El-Jadida, and Beni Mellal), this number may reach around 100 scientists or 25 potential RYs. However, most of these scientists are overloaded by their education commitments, and their physical and financial resources are generally poor.

### The Other Technical NARS Institutions

The Directorate for Agricultural Training, Research and Development (DERD) - For fulfilling its mandate, DERD has recently (since 1995) created Centers for Training, Research and Development (CFRDs: *Centres de Formation, de Recherche et de Développement*), which aim to strengthen collaboration between the NARS institutions and the linkages with development organizations in each large agroecological region of the country. These CFRDs mobilize the resources of the concerned institutions and add specific human and financial resources needed for the activities and projects they intend to develop. Currently, there are two categories of CFRDs:

- Four CFRDs have been set up in regions where permanent presence of the NARS institutions is very limited or nil; they are located at Errachidia, Ifrane, Missour and Tétouan, specialized in the Saharan zone, Atlas mountain/forestry, pastoralism/rangeland zone (east-central part of the country), and Rif (northern) mountains, respectively. These CFRDs have benefited from rather large efforts, including recruitment of around 20 permanent graduate staff members and new infrastructure (offices, lecture rooms, labs, housing, etc.) for permanent staff and visiting scientists (and students) from the NARS institutions.
- Four CFRDs are based on existing units of some NARS institutions: Agadir for horticulture (within IAV), Meknès for rainfed agriculture and animal production (within ENA), Rabat for rural agricultural engineering, food technology, veterinary medicine (within IAV), and Serrat for dry areas (within the largest INRA regional center). These CFRDs will essentially take advantage of the existing infrastructures and will try to associate scientists and students from other NARS institutions interested in the four mentioned agro-systems.

Currently, the additional AR resources directly mobilized by the CFRDs (apart from the resources of the NARS institutions allocated in their activities, taken into consideration in the previous sections) are limited: around 8 pRys (20 permanent graduate staff of the four first CFRDs who allocate around 40% of their time to AR) and Dh 30 million (US\$ 3.4 million) provided by DERD and through contracts with national development organizations. In the near future, these resources may greatly increase through the planned recruitment of 50 new graduate staff members and scheduled external financial support.

The Other MADRPM Directorates Involved in AR - Within their mandate, some MADRPM directorates implement AR activities. The Directorate for Plant Protection, Chemical Control and Fraud Prevention is involved in applied research in crop protection (epidemiology, integrated pest management), food technology, etc. The Animal

Production Directorate is involved in research on animal genetics, nutrition, health (mainly research in epidemiology conducted by the laboratory for vaccine production), food technology (meat/milk quality), and economics. These directorates dedicate some 40 pRYs and Dh 25 million (rough estimate) directly to AR activities, without counting the resources mobilized by scientific institutions (mainly IAV) through research contracts funded by the directorates.

**The Other Organizations** - For supporting their development mandates, some public agricultural enterprises and professional organizations carry out applied AR activities (crop, irrigation and/or livestock experiments, farming systems and socioeconomic studies) alone or more often in close collaboration with the public sector (IAV, ENA, INRA, etc.) as part of their research activities or through research contracts. These are:

- The Regional Authorities for Agricultural Development (ORMVAs), which supervise public intervention in some irrigated and rainfed areas<sup>1</sup>; the National Society for Land Management (SOGETA), which directly manages state properties (inherited from the nationalization of former French farms); the National Society for Agricultural Development (SNDIA); the National Society for Livestock Development (SNDE); and the Society for Agricultural Development (SODEA).
- The professional organizations or associations set up by some of the more active farmers specialized in commodities such as citrus, vegetables, cut flowers, and bananas; some of them (such as the *Société Agricole de Services au Maroc*, SASMA, for citrus, which is endowed with some researchers and an experimental farm of 50 ha) have their own laboratories, scientists and extensionists, and are funded by a levy on exported produce.

The resources directly devoted to these AR activities have not been precisely inventoried. They may mobilize some 40 pRYs and Dh 25 million (rough estimates).

### 3. AR RESOURCES

#### 3.1 Human Resources

In 1997, the Moroccan NARS involved 1073 scientific and technical graduate staff (29 of whom were expatriates), who represent around 606 potential RYs.

The agricultural scientific institutions employ 864 national scientists (313 PhD, 453 MS and 98 BS) who represent over 80% of the total graduate staff. The academic level of these scientists is much higher at the AHE institutions (58% with PhD degree, 39% with MS) than at the AR institutes (15% with PhD degree, 66% with MS). At INRA, the training policy and recent enhancement of the status and salaries of researchers have led to obvious improvement; however, there seem to be no favorable prospects for CNRF and SEEN whose scientists follow the same salary scale and career scheme as public servants.

NARS graduate staff is highly concentrated in Rabat (496: 46%), largely because of the weight of IAV. Recent efforts have been made to change this situation with the creation of the regional CFRDs; however, many regions are far from having a sufficient number of permanent scientists able to efficiently meet their AR needs.

The number of technicians per scientist is highly variable from institution to another (INRA: 1.1; CNRF: 0.7; SEEN: 3.1; INRH: 0.8; IAV: 0.4; ENA: 0.5). Because many technicians are assigned to administrative positions (clerks, etc.), their numbers are very insufficient (compared with the common norm of 2 technicians per researcher in AR institutes) and constitute a strong limiting factor constraining scientists' research efficiency.

In general, other support staff (laborers, clerks) are sometimes too numerous and not very productive, but rather inexpensive<sup>2</sup>.

#### 3.2 Physical Resources

The physical resources are impressive. The Moroccan NARS possesses about 65 physical units (headquarters, regional centers, farms) of a total area of about 7,000 ha. A large majority of these units, which are rather well spread

<sup>1</sup> The major ORMVAs of the irrigated schemes of Doukkala, Errachidia, Gharb, Haouz, Moulouya, Ouarzazate, Souss Massa, have 13 experimental stations, totaling more than 200 ha.

<sup>2</sup> The monthly salary of this low-qualified staff is about Dh 1,500–2,000 (US\$ 170–230) compared to the following salaries for qualified staff (average estimated from different scientific institutions): senior scientist with PhD, Dh 11,000 or US\$ 1,300/month; researcher with MS, Dh 8,000 or \$ 910; research assistant, Dh 5,000 or \$ 570; technician, US\$ 350.

across the country, is run by INRA. In general, land is sufficient and library/documentation services are considered satisfactory, but the other physical resources (offices, laboratories, scientific equipment, computers, transport/communication facilities) are unevenly distributed among the institutions and among the units of the same institution, with only few units (Rabat, Settat for INRA; IAV; ENA) currently being well endowed, thanks to recent investments mostly funded by external sources (grants and loans).

### 3.3 Financial Resources

In 1996–98, the total (national and external) annual NARS financial resources amounted to an average of about Dh 355 million (US\$ 40 million), of which Dh 320 million (US\$ 36 million) came from national sources (mainly the government budget, in addition to some self-earned institutions' resources and research contracts funded by national organizations), Dh 26 million as a loan (from the World Bank to INRA), and Dh 9 million from external grants provided by bilateral or multilateral donors.

The NARS national and total resources amounted to around 0.68 and 0.76%, respectively, of the Agricultural Gross Domestic Product (AGDP) estimated at US\$ 5.3 billion in 1996). Such ratios are lower than the 1% recommended by some international organizations.

INRA and INRH enjoy good operating and capital budgets (US\$ 29,000 per pRY and US\$ 35,00 per graduate staff member, respectively), which may be sufficient for providing almost satisfactory resources for their research staff<sup>1</sup>. On the other hand, CNRF, SEEN and the AHE institutions suffer low research operating and capital budgets (CNRF and SEEN: US\$ 4,200 and 9,700 per pRY, respectively; IAV: US\$ 4,800 per academic staff member), which prevent (together with other factors, especially the insufficient number of technicians) a fair mobilization of their scientific potential. Therefore, the NARS should account for **around 540 actual RYs** (about 400 of which would be for the four AR institutes, 70 for the AHE institutions, and 70 for the other NARS institutions) as opposed to the 606 potential RYs estimated above.

## 4. RESEARCH ACTIVITIES

### 4.1 Research Orientation and Priorities

Each institution has developed research programs and activities in its fields of competence and mandates. As seen above, research programs differ largely among the NARS institutions. Through the PBO system, INRA has tried, and partly succeeded in, conducting long-term programs based on a rational appraisal of the priority needs of the agricultural sector, with rather sustained funding sources; while the AHE institutions have developed short-/medium-term programs, mainly initiated according to changing research contracts.

These complementary approaches should be of mutual benefit to the scientific institutions and enhance their whole research activities within the framework of strong collaboration which does not exist. Despite formal past efforts, linkages between the scientific institutions, mainly between the two largest ones: INRA and IAV, are rather weak, sporadic, and based on personal contacts<sup>2</sup>; each institution follows its way without taking advantage of the results and experiences of the others. This results in a non-integrated aggregate research program, with unbalanced coverage of AR needs; some fields seem to be insufficiently taken into consideration (rainfed regions with favorable conditions, pasture/rangelands, animal production, food technology, rural economics, etc.), while there is duplication of efforts in some areas. A comprehensive critical balance of the overall current AR programs has never been made.

### 4.2 Linkages with Development

<sup>1</sup> Most of the national AR long-term plans elaborated by developing countries during the 1990s consider an average annual operation and capital budget of US\$ 25,000–30,000 per researcher for covering all AR expenses (research and administrative costs, except the salaries of the permanent staff); such norm is valid for a full set of research domains and varies slightly according to the field (higher costs for perennial crops, animal production, food technology, etc. than for annual crops, rural economy, etc.).

<sup>2</sup> In spite of the recent agreement signed in 1995 between INRA and IAV, which describes the various linkages to be formalized between the two institutions and calls for the establishment of joint scientific committees to expand collaborative AR programs (funded by national or international organizations) and activities (exchange of scientific events, sharing of information, etc.).



Most of the scientific NARS institutions have a rather rich experience in establishing various linkages with their development partners: government agencies, professional organizations or the private sector. Some of these linkages are specific to one institution (such as the PBO and the research and development units in each regional center of INRA). But most channels are similar and sometimes leave room for strong competition between the institutions, such as the INRA national and regional sectorial committees, the professional associations set up by IAV, research contracts with national and external organizations, demonstration experiments in farmers' fields, field-days in experimental stations, services (soil and water analysis, etc.), workshops, training courses, etc.

Such competition is good to a certain extent, but it may imply a waste of energy and resources. It could also lead to a weakening of the scientific institutions in terms of their relations with their national and external partners. The recent creation of the Inter-Professional Groups for Agronomic Research (GIRA: *Groupeement Interprofessionnel pour la Recherche Agronomique*), established for involving the private sector in research orientation and funding, and of the National Committee for Transfer of Technology (CNTT) and Regional Committee for Transfer of Technology (CRTT) should be fully profitable to the scientific institutions only if they are able to develop better relations among themselves.

### 4.3 International Cooperation

In general, the scientific institutions of the NARS have large and diversified international partnerships with scientific institutions from developed countries (European Union, France, Germany, USA, etc.) and from the WANA region (directly but mainly through ICARDA), and with international/regional centers or organizations (CIMMYT, ICARDA, CIHEAM, FAO, AARINENA, ACSAD, etc.). However, effective relations implying collaborative research programs and external funding remain relatively limited with regard to the size of the NARS.

## 5. CONCLUSION

The Moroccan NARS remains moderately fragmented, with three major institutions (INRA, INRH and IAV) mobilizing about 70% of the total pRYs and financial resources. Its human and financial resources are rather limited with regard to the size of the country and the difficult long-term food prospects resulting from the growing population and limited natural resources.

The major AR institutes (INRA and INRH) and the AHE institutions have complementary characteristics. Closer collaboration among these institutions would greatly benefit the NARS; however, little has been done to promote such collaboration, either by the institutions concerned or by MADRPM; this has resulted in sub-optimal use of the available human, physical and financial resources. Effective collaboration between the scientific institutions of the NARS could be considerably enhanced, as indicated by Besri and El Idrissi (FAO, 1996), by:

- Joint preparation of the national agricultural policy and identification of research priorities, with a view to strengthening coordination of the research activities of the various institutions involved.
- Joint discussion of budgets and program priorities.
- Pooling human resources (scientists and technicians) in similar areas of specialization, especially of highly trained staff, for implementing joint research tasks, and establishing joint laboratories.

This should be possible under a renovated body responsible for the national AR policy, which is able to boost concrete actions and mobilize larger funds.

### Main Acronyms

MADRPM: Ministère de l'Agriculture, du Développement Rural et des Pêches Maritimes.

CFRDs: Centres de Formation, de Recherche et de Développement. CNRF: Centre National de la Recherche Forestière. DERD: Direction de l'Enseignement, de la Recherche et du Développement. ENA: Ecole Nationale d'Agriculture de Meknès. ENFI: Ecole Nationale Forestière d'Ingénieurs de Salé. IAV: Institut Agronomique et Veterinaire Hassan II. INRA: Institut National de la Recherche Agronomique. INRH: Institut National de Recherche Halieutique. SEEN: Service de l'Expérimentation, des Essais et de la Normalisation.

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Table 1 - The National Agricultural Research System (average 1996–1998)

Indices: Approximate data. -: Data not available. 0-: Minimal (almost zero). \*: See footnotes.

NARS Institutions				AR Scientific & Technical Graduate Staff (Units)			Potential Res. Years (pRY)		Total Budget (million Dh)		AR Expenditures/Resources (E) (million Dh)					
No.	Name - Acronym Head Office - Year Established		Mandates AR Fields	Govern. Ministry	Nationals Total - (PhD, MS)		Exp.	Nat.	Exp.	Nat.	Ext.	Nat. E NE	Loan LE	For. E FE*	Total E TE	
a	b		c	d	e	f	g	h	i	j	k	l	m	n	o	
1.1	Institut National de la Recherche Agronomique Rabat	INRA 1919-81	AR (90%) - AD All (except 2.1, 2.2)	MADRPM	282	50, 196	18	254	16	134	32	127	26	6	159	
2.1	Centre National de la Recherche Forestière Rabat	CNRF 1934-...	AR (90%) - AD Forestry		36	1, 35	1	32	1	17	0-	16		0-	16	
2.2	Service d'Expér., d'Essais et de Normalisation Rabat	SEEN 1952-...	AR (80%) - AD Water resour. manage.		17	4, 12		14		7	0-	6		0-	6	
2.3	Institut Nat. de Recherche Halieutique Casablanca	INRH 1952-96	AR (70%) - AD Marine resources		99	10, 42		70		48	0-	41		0-	41	
1-2	Total Agricultural Research Institutes				434	68, 285	19	370	17	206	32	190	26	6	222	
3.1	Institut Agronomique et Vétérinaire Hassan II Rabat, Agadir	IAV 1967	AHE - AR (30%) - AD All	MADRPM	315	194, 113	2	78	1	156	8	33		3	38	
3.2	Ecole Nationale d'Agriculture Meknes	ENAM 1945	AHE - AR (15%) - AD All		88	39, 44	5	22	2	35	2	3		0-	5	
3.3	Ecole Nationale Forestiers d'Ingenieurs Rabat/Sale (→ Ifrane)	ENFI 1968	AHE - AR (15%) - AD Forestry		27	15, 11	3	7	1	10	1	0-		0-	0-	
3	Total Agricultural Sciences Graduate Schools				430	248, 168	10	107	4	192	11	40		4	43	
4.1	Univ. Marrakech, Meknes, El-Jadida, ...		HE - AHE - (AR) Diverse	MES	80	...	0	20	0	...	...	10	...	...	10	
4	Total Other Scientific Institutions				80	...	0	20	4	...	...	40	...	...	80	
5.1	Centres de Formation, de Rech. et d. Développement Errachidj, Ifrane, Missour, Tétouan, ...*	CFRD 1993-...	AHME-AR (40%) - AD All	MADRPM	20*	...		8*		...	...	30*		...	30*	
5.2	MADRPM Central Directorates*		AD - (AR)		40*	...		40*		...	...	25*		...	25	
5.3	Public/Professional Agr. Development Bodies*		AD - (AR)		40*	...		40*		...	...	25*		...	25	
5	Total Admin./Dev./Service Institutions Involved in AR				100	...	0	20	0	...	...	80		...	80	
6	Total NARS				1044	...	29	585	21	...	...	320	26	9	355	
Exchange Rate: US\$ 1 = 8.8 dirhams (Dh) (1996 average official rate)					Approximate Actual Res. Years (pRYs)				520	20	AR Expenditures (million US\$)		36.3	3	1	40.3

MADRPM: Ministry of Agriculture, Rural Development, and Marine Fisheries; MES: Ministry of Higher Education; e: Mandates: AR (%): Approximate average % of human resources devoted to ag. research (AR); R: Research; AHE: Ag. higher education; AHME: Ag. high and medium education; HE: Higher education; AD: Ag. development/services (for AR and AHE institutes: seed production, soil and water analysis, extension, studies, etc.); h: Potential research year (pRY) = equivalent full-time researcher, for the FAOs, the pRYs were estimated by multiplying the number of academic staff by 0.25. For the AR institutes, AR financial resources were roughly estimated through the following formula: Total budget  $\times$   $(\frac{1}{10} + 0.5(100\% - m))$ , m being the % of time devoted to AR by the graduate staff; n: FE: the expenditures on services on estimated at "national costs" (a national senior staffs average unit cost).

\* Notes: 5.1, 5.2, 5.3: Only the professional staff (in RYs) and financial resources allocated to AR activities. 5.2: Central Directorates of Crop Protection, Animal Production. 5.3: Regional Offices: SOGETA, SNDE, SASMA, ... National AR expenditures (NE) = 0.68% of the Agricultural Gross Domestic Product (AGDP: US\$ 5.3 billion in 1995). Total AR expenditures (TE) = 0.76% of the AGDP.

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF TUNISIA<sup>1</sup>

## I. HISTORICAL BACKGROUND

Agricultural research (AR) in Tunisia started more than a century ago with the establishment of three institutions: the *Service de l'Élevage* (Animal Production Service) created in 1887, which became the *Institut de Recherche l'Étérinaire* (IRV) in 1913; then in 1889, the *Ecole Coloniale d'Agriculture de Tunis* (Colonial Agricultural School of Tunis, for technicians), elevated to the status of *Ecole Supérieure d'Agriculture de Tunis* (ESAT, College of Agriculture for Graduate Studies) in 1955; and the *Service Botanique de Tunisie* in 1913, renamed *Service Botanique et Agronomique de Tunisie* in 1936 (SBAT).

After independence in 1957, the national authorities gave high attention to agricultural research and education, which received support from many cooperating agencies. SBAT became the *Institut National de la Recherche Agronomique de Tunisie* (INRAT, National AR Institute of Tunisia) in 1961, which relied heavily on cooperation with INRA France. New research institutes were established:

- The *Centre de Recherche et d'Expérimentation du Génie Rural* (CREGR, 1959), then renamed *Centre de Recherche du Génie Rural* (CRGR) after merging in 1970 and 1974 with two research and development projects on irrigation<sup>2</sup>;
- The *Institut du Reboisement* (Institute for Reforestation), opened in 1966 with FAO support, renamed *Institut National des Recherches Forestières* (INRF, 1976);
- The *Institut des Régions Arides* (IRA: Institute for Arid Regions), established in 1976 to capitalize on the experience gained since 1969 in research and studies implemented with French scientists in the south of the country (rangeland management, oases);
- The *Institut de l'Olivier* (IO), established at Sfax in 1981 for promoting the important olive sector;
- The *Institut National des Sciences et Technologies de l'Océanographie et de la Pêche* (INSTOP, 1964), a new name given to a marine center established in 1924.

At the same time, ESAT developed and became the Faculty of Agriculture of Tunis, then the *Institut National Agronomique de Tunis* (INAT) in 1970. The higher agricultural education system expanded dramatically. One veterinary school and seven *Ecoles Supérieures d'Agriculture*, equivalent to colleges, were established during the period 1970–1983, namely:

- *Ecole Nationale de Médecine Vétérinaire* (ENMV, 1974) at Sidi-Thabet (north of Tunis), for training veterinarians until then trained abroad;
- Six agricultural colleges for training technicians and engineers (equivalent to diploma and BS holders) in specialized fields (dry area farming systems, animal production, etc.)<sup>3</sup> and one college for training forestry technicians (see Section 2.3).

In 1990, the Ministry of Agriculture (MOA) set up the *Institution de la Recherche et de l'Enseignement Supérieur Agricoles* (IRESA, Institution for Agricultural Research and Higher Education) responsible for the supervision and coordination of the former agricultural research and training institutions (all so far affiliated to MOA), setting their priorities and developmental needs, monitoring and finalizing their research programs and valorizing their findings and results.

<sup>1</sup> By **Dr Mustapha Lasram**, *Chargé de mission* at the Cabinet of the Minister of Agriculture, former Secretary General of CIHEAM, Paris, and **Dr Mohamed Salah Mekni**, Director General of INRAT, former Regional Coordinator of the North Africa Regional Program of ICARDA.

<sup>2</sup> These projects, sponsored by FAO, were the *Centre de Recherche sur l'Utilisation des Eaux Saumâtres en Irrigation* (CRUESI, 1962–1970), and the *Centre d'Amélioration des Techniques d'Irrigation et de Drainage* (CATID, 1969–1974), respectively focusing on the use of saline water for irrigation and on the improvement of irrigation and drainage techniques.

<sup>3</sup> Most of these colleges came before agricultural high schools which trained low- and medium-level technicians.

In 1978, the national research policy was conferred to the Ministry of Higher Education; however, it had very limited influence on the NARS institutions affiliated to other ministries. In 1991, the *Secrétariat d'Etat à la Recherche Scientifique et la Technologie* (SERST), under the Prime Minister's Office, took over very actively this responsibility: it launched the national priority research projects (*Projets Nationaux Mobilisateurs*: Mobilizing National Projects) in line with the development strategy (industrial management, seashore and environment management, water management, remote sensing, desertification control, etc.). It has stimulated collaboration among the national scientific institutions, set up new research units (especially within the universities), and taken direct governance of some research institutes such as IRA and INSTOP (1992).

Lately, IRESA has developed a regionalization scheme articulated around seven "regional development poles." In 1996, the following changes occurred: CRGR and INRF merged into a single research institute, the *Institut National de la Recherche en Génie Rural Eaux et Forêts* (INRGREF, 1996); IO mandate was extended to fruit trees cultivated in dry areas; and INSTOP became INSTM, *Institut National des Sciences et Techniques de la Mer* (National Institute for Sciences and Techniques of the Sea), after merging with the National Center for Aquaculture (CNA, created in 1985).

## 2. THE CURRENT NARS

### 2.1 Overview (see Table 1)

The current (1997) Tunisian NARS is composed of two main sets of institutions:

- Six AR institutes, of which four (INRAT, INRGREF, IO, IRVT) are affiliated to IRESA within MOA, and two are under SERST (IRA, INSTM): they gather around 61% of the potential research years (pRYs or equivalent full-time researchers) and 72% of the total financial resources of the NARS; they are presented in Section 2.2.
- Nine agricultural academic institutions affiliated to IRESA, which meet around 25% of the pRYs and 15% of the total financial resources of the NARS (see Section 2.3).

Some other institutions within different ministries (SERST, MOA, etc.) for which AR activities represent a relatively small part of their mandate, fill the remaining marginal place in the NARS (see Section 2.4).

IRESA<sup>1</sup>, on behalf of MOA, has the largest mandate in the national AR policy. SERST is responsible for the overall national research policy and, at the same time, directly governs IRA, INSTM and other research institutions (INRST, CBS, etc.).

### 2.2 The AR Institutions

#### The IRESA Agricultural Research Institutes: INRAT, INRGREF, IO and IRVT

##### Mandate and Organization

Among the four IRESA AR institutes (ARIs), three are mainly involved in research, which mobilizes around 85% of the time of their researchers, with little development (seed/seedling production, soil/water analysis, studies, etc.) and training activities; they are:

- The National Agricultural Research Institute of Tunisia (INRAT, headquarters: Tunis). It is the largest NARS institution, employing 86 graduate staff members, who represent 73 pRYs<sup>2</sup>. It conducts research in almost all agricultural fields, except olive tree research and farm machinery. INRAT is headed by a Director General supported administratively by a Secretary General; the DG chairs a Board where the various scientific and professional partners are represented. It has very strong links with professional organizations.
- The National Research Institute for Water Management, Forestry and Agricultural Engineering (INRGREF, Tunis): The main research thrusts of its 40 graduate staff members are in the areas of soil conservation, land management, irrigation management, crop water use, sewage water use, etc.

<sup>1</sup> IRESA is an administrative division of MOA, with autonomous budget. It is headed by a President and a Director General. Its organizing chart includes five main Directorates: pedagogic affairs; planning, monitoring and evaluation of research programs; transmission of innovations and liaison between research and extension; scientific information; international cooperation.

<sup>2</sup> pRYs = number of researchers × 85% (percentage of the researchers' time devoted to AR).

- The Olive Institute (IO, Sfax). Its 25 researchers are specialized in research related to fruit trees (production and technology) cultivated in dry areas (mainly olive, and also pistachios and almonds trees).

The Tunisian Veterinary Research Institute (IRVT, Tunis) is mainly involved in development/service activities (vaccine production, food quality control, epidemiology surveys, etc.) which mobilize a major part of its graduate staff's time, with a minor part devoted to research on animal health.

These semi-autonomous ARIs have the status of public administrative institutions; they are financially autonomous and are headed by directors general nominated by the Minister of Agriculture, assisted by scientific councils, comprising researchers and representatives of socioeconomic and professional organizations.

#### Human, Physical and Financial Resources

The permanent full-time staff of the IRESA ARIs is national and includes (1996):

- 168 graduate staff members (30 PhD holders), who are equivalent to 131 pRys;
- 197 technicians, i.e. an average of 1.2 technician per researcher (from 1.1 at INRAT to 1.9 at INRGREF), rather low for meeting the research needs;
- 788 other support staff (53 administrative staff and 735 laborers), which means an average ratio per researcher of 4.7; much lower and more satisfactory than 10 years ago (almost 8: ISNAR, 1987). IO is now facing a large deficit (ratio of only 1.8).

The graduate staff members are under two different categories. The largest is the "scientific staff" (around 70%) who is under the "scientific status" obtained in 1987 (see Section 3.1) with its three main grades: director, master and assistant of research, and have, in general, a postgraduate degree (PhD, MS or equivalent). The remaining senior "technical staff" covers three sets of qualified staff: (i) all the IRVT graduates (almost all are veterinarians and till now their diploma has not been taken into account in the IRESA scientific status); (ii) old IRESA researchers who are under the former status applied to the senior staff of the MOA services; these researchers generally were not or could not be integrated in the scientific status because they don't have a postgraduate degree, in spite of (for most of them) their valuable past research experience; and (iii) young researchers who are under contract and are preparing the research assistant examination (and generally a postgraduate degree) while participating in research programs.

The four ARIs have their main laboratories at their headquarters. Their 28 experiment stations (19 belong to INRAT, 8 to INRGREF, 1 to IO; total area: 4,450 ha) spread across the country are too numerous; they suffer insufficient numbers of technicians and laborers (whose number was cut by two-thirds in 15 years), and their management is rather difficult, as each station is supervised by a researcher, responsible for its management, who is generally based in Tunis and does not receive any incentive (material or academic) for his management duties. In general, infrastructure (buildings, offices, labs) and scientific equipment are rather satisfactory, thanks to the renovation and purchases funded by a World Bank loan; however, the number and quality of vehicles are insufficient due to the lack of replacement and maintenance.

In 1996, the total "direct" financial resources<sup>1</sup> of the IRESA ARIs amounted to D 8.28 million (D: Tunisian dinar, almost equivalent to US\$ 1), of which D 6.73 million came from national sources (mainly the state budget, and some self-generated funds), D 1.37 million from a World Bank loan allocated for capital expenditures (US\$ 7 million for 5 years), and D 0.18 million as foreign research grants.

Around D 4 million is allocated to salaries<sup>2</sup> and D 4.3 million to operation and capital costs (OCC). An estimated D 7.3 million is used for research activities, of which around D 3.8 million is for OCC, including D 2.3 million from national funds and D 1.5 million from external sources (loan and grants). The origin of the OCC (60 and 40% from national and external sources, respectively) reflects the high dependence on external sources, mainly from the World Bank loan. The available OCC for AR represents about D 29,000 per pRY. Although this amount appeared to be reasonable (see Section 4.3), it has actually deteriorated during the last years till the completion of the World Bank loan and its temporary prorogation (1997–1998), such that at present, researchers consider OCC as rather inadequate, as well as largely allocated to the experimental stations and mobilized with difficulty (bureaucratic financial procedures, frequent delays in disbursements).

#### Research Activities

<sup>1</sup> Without considering the resources used by IRESA Directorate for the overall management of the ARIs.

<sup>2</sup> Salary costs consume about 70% of the total national budget (79% for INRAT, 50% for IRVT).

Until recently, the research programs were, in most cases, defined mainly by the researchers themselves, taking into account their promotion requirements and the national objectives and needs. The National Committees for Research Planning, set up since 1992 (see Section 4.1), provide the basis for an improved system of priority setting, appropriate budgeting, and monitoring and evaluation; however, these Committees cover priority AR fields and are not fully operational (monitoring and evaluation have not been periodically implemented till the present time).

### **The SERST-Affiliated Agricultural Research Institutes: IRA and INSTM**

The Arid Zones Institute (IRA) - IRA<sup>1</sup> conducts research related to agricultural production and rangeland management in the south of the country under harsh conditions and in oases, and addresses desertification concerns. Headquarters' research at Medenine is primarily concentrated on soil preservation, the Kebili station concentrates on plant protection and protection of highland oases, the Gabès station is responsible for coastal oases concerns, and the Ben Guerdane station works on rangelands.

IRA permanent staff include 43 researchers (all MS), 37 technicians (only 0.8 per researcher) and 133 support staff (33 administrative employees and 100 laborers: 3.1 per researcher). Physical facilities at the headquarters (where most of the laboratories are located) and in the 5 experiment stations (total: 207 ha, of which 167 ha is at Medenine) are rather good. IRA financial resources amount to D 2.4 million (coming essentially from the state budget); around 70% of these resources are allocated to salaries and 30% to OCC (about D 19,000 per pRY).

The National Institute for Sciences and Techniques of the Sea (INSTM) - This new institute is an "administrative scientific institutions;" it combines the former INSTOP and CNA which are still keeping their specificity:

- The "INSTOP branch" (headquarters in Salambo/Tunis) focuses on fish and related research activities. It has 38 researchers, a boat for its research marine campaigns, and an aquaculture center at Monastir.
- This former CNA is specialized in research, experimentation and extension of techniques of aquaculture and fish production. Its mission is to improve breeding and raising techniques of fish and sea organisms, to train professionals in the aquaculture sector, and to promote the sector.

These two units manifest common characteristics (as compared with the IRESA ARIs):

- Their scientific staff has a slightly lower academic level, and they suffer large deficit in technicians and laborers;
- Their financial resources come mainly from the national budget (limited foreign grants, no loan) and are relatively small: the 1996 OCC per pRY was around D 13,000 at INSTOP and D 8,000 at CNA, which is obviously far from meeting the research needs (relatively more expensive for oceanography, fisheries, aquaculture than for crop and animal production).

The IRA and INSTM research missions are closely coordinated with IRESA programs.

## **2.3 The Nine IRESA Academic Institutions**

### **Overview**

The nine IRESA academic institutions are:

- the National Agronomic Institute of Tunis (INAT), the oldest and largest (105 academic staff members: asm), provides training programs for undergraduate and post-graduate degrees (MS and PhD initiated in 1978 and 1988, respectively) in several fields<sup>2</sup>;
- the National College of Veterinary Medicine of Sidi-Thabet (ENMV, with 47 asm), which offers an MS degree in animal health;
- six specialized colleges which offer technicians' and engineers' degrees (equivalent to diploma and BS): the College for Horticulture and Animal Production of Chott-Mariem (ESIE, created in 1975, 52 asm); the Field Crops College of Le Kef (ESAK, 1983, 20 asm); the College for Animal Husbandry of Mateur (ESAMa, 1976,

<sup>1</sup> IRA was a unique ARI with the status of an "industrial and trading public institution," which allowed flexible financial management, including higher specific salary scales. In December 1998, it got the same status of "scientific and technological public organization" as the other ARIs.

<sup>2</sup> INAT has 6 large training/research departments: physical, chemical, computer sciences; crop sciences; animal and fishery sciences; applied biology and food technology; agricultural engineering, water management and forestry; rural economics and development.

27 asm), the College for Irrigation, Agricultural Equipment/Machinery of Medjez El-Bab (ESIERM, 1976, 42 asm); the College for Food Industry/Technology of Tunis (ESIAT, 1985, 21asm); the College for Rural Economy of Moghrane (ESAMo, 1981, 36 asm); and

- the Forestry and Pastoral Institute of Tabarka (ISPT, 1970, 12 asm), which trains technicians in forestry and pastoralism.

Academic matters are under the supervision of the Ministry of Higher Education (MES), while administrative aspects are the concern of MOA through IRESA, and research matters supported by IRESA and SERST. The precise task of each ministry is not well defined.

On average, according to the heads of the training institutions, the academic staff members may allocate around 70% of their working time to teaching activities (lectures and student supervision), 25% to AR (see below) and 5% to extension activities (present in the four colleges located outside the large region of Tunis).

The nine training institutions currently (1997) have 1,122 permanent employees, of whom 362 are academic staff (including 128 PhD) who represent 91 potential RYs<sup>1</sup>.

The total annual budget (around D 10.3 million in 1996) is funded essentially (93%) by national sources (state budget, few self-generated funds), with marginal external funds (D 0.4 million from the World Bank loan for research capital expenditures; D 0.3 million from foreign grants). It is mainly used for educational purposes; D 6 million are allocated to salaries and D 6.5 million for all other expenses (including student fellowships and boarding).

### Research Activities

Research activities at the academic institutions are generally constrained by many factors (Chennoufi and NeZaoui, FAO, 1996):

- Limited support staff: the 111 technicians (i.e., 0.3 per asm) and 648 laborers (1.8 per asm) present in the nine academic institutions are insufficient and mainly mobilized for education activities (lab/farm practices).
- Inadequate research physical resources: each institution (except ESIAT) has an experimental farm for education and research work, but laboratories are generally not well equipped, farm machinery and vehicles are insufficient in most cases, and maintenance of research facilities was rated insufficient in five colleges.
- Inadequate research funding: most of the academic institutions have no specific budgets for research activities and have to rely on limited external funds.
- Poor institutional research management: the scientific committees of the academic institutions are expected to orient research programs, and to follow up on their progress, but they only deal with academic aspects, due to this lack of institutional monitoring, most research programs are identified and executed individually.

Finally, AR at the IRESA academic institutions is carried out mainly by young academic staff members and graduate students. Direct involvement in AR of the senior academic staff members is rather limited and actually represents about 10% of their time, which gives around 36 actual RYs for the nine IRESA academic institutions.

## 2.4 The Other Institutions of the NARS

### The Other Scientific Institutions Contributing to the NARS

The Institut National de la Nutrition et de la Technologie Alimentaire (INNTA, Tunis) - Established in 1966, it is affiliated to the Ministry of Health. In addition to research on health through research on diets, research related to agriculture deals with biological analysis of plant and animal/feeding composition, food technology planning and control of the nutrition policy of the population. INNTA has 37 scientists, of whom 16 are involved in food technology. Its total budget is D 1.85 million and the AR-related budget is around D 0.85 million.

The Centre de Biotechnologie de Sfax (CBS) - Created in 1988, it is affiliated to SERST. Around 5 out its 20 researchers specialize in biotechnology applied to agricultural areas (tissue culture and production of disease-free plant material).

<sup>1</sup> Taking into account the normative rate of 25% of the academic staff members' time allocated to AR activities adopted for the analysis of all the NARSs of the WANA region (see methodology of the study).



The Institut National de la Recherche Scientifique et Technique (INRST) - Created in 1980, it deals with different areas of biology and technology research: tissue culture, plant germplasm conservation, solar energy and other renewable energies and water desalination.

Some Faculties/National Higher Schools of Sciences, Engineering, and Economics (Tunis, Sfax, etc.) employ a large number of staff members qualified in scientific fields related with agricultural and rural activities (plant and animal biology, agricultural engineering, food processing, rural social sciences). A precise inventory of this scientific potential is not available; however, according to a rough survey, this number may reach at least 60 academic staff members, who represent 15 pRYs. Most of the AR, if not all, is carried out through graduate students working on their doctorates. This research is often limited in time and scope but is generally of good quality. Its direct impact on agriculture is insignificant. Professors can devote only little time to carry out research themselves; however, links with AR institutions are good (mainly academic training of junior AR researchers at universities; scientific and physical support given to university students by INRAT and INRGREF scientists; joint publications).

### **The Other Non-Scientific Institutions Contributing to the NARS**

The Bureau pour l'Inventaire et la Recherche Hydrologiques (BIRH) - It is an MOA service created in 1981, based at Tunis. Its 30 graduate staff members are involved in development and research activities related to water resources management. BIRH is responsible for establishing detailed inventories of surface and deep-water reserves of the country. It is also responsible for assessing and following up on rainfall and related rain-off and determining optimum rates of exploitation. Monitoring of these water resources is an essential task.

The Direction des Sols (DS) - This directorate, directly attached to MOA, is located on the INRAT/ INRGREF campus. Eleven scientists are working in the fields of pedological studies and mapping, soil potentiality and fertility.

The Centre National d'Etudes Agricoles (CNEA) - Created by MOA in 1973, CNEA (17 graduate staff members) implements studies in rural socioeconomic, which can be considered as partly similar to research.

The Centre National de Télédétection (CNT: National Center for Remote Sensing) - Established in 1988, CNT is a public institution under the Ministry of Defense. Its primary role in agriculture is to provide reliable data and information to major national production and development projects. Nationally, CNT is responsible for providing directions on national policy regulations in the areas of GIS, aerial photos, etc. It is also the principal national trainer of staff and is in charge of promoting the various remote sensing applications. Its major research thrusts are in the areas of desertification, marine pollution, floods, seashore, and environment management. CNT is the Tunisian partner of all international agencies related to "Agenda 21" and works on sustainable environment projects.<sup>1</sup>

## **3. AR RESOURCES**

### **3.1 Human Resources** (see Table 1)

The Tunisian NARS (1996/97) involves around 780 scientific and technical graduate staff (all national), who represent some 400 potential RYs (without counting INRST and CNT for which precise data could not be obtained).

Out of the 638 graduate staff members of the agricultural scientific institutions (ARIs and IRESA academic institutions), 163 have a PhD degree (26%). The level of academic training is much lower in the ARIs (only 18% with PhD degree) than in the academic institutions (35% with PhD). This difference results mainly from past problems of the career scheme/status of the researchers of the ARIs: till 1987, they were considered as MOA senior staff and their salaries were half of those of the academic staff members; therefore, most of the researchers with PhD went to academic institutions. The adoption in 1987 of a status similar to university staff members has partially solved this problem: (i) it dealt mainly with young researchers and left aside many of the old experienced researchers who did not have a PhD to join the new researchers' scheme/status; and (ii) within the IRESA institutions, salaries of the ARI researchers are still slightly lower (10–20% less according to the grades) than those of the academic staff members.

Around 75% of the graduate staff members are located in and around Tunis; in the other regions (except the center-east and the south), the numbers of scientists are obviously too small. No perceptible progress has been made since the elaboration in 1985 of the long-term plan (with the support of ISNAR) which proposed to reduce this percentage to 50%, in spite of the creation of the seven regional development poles during 1997/98 (see Section 4.2).

<sup>1</sup> No precise information on the resources of this Center could be obtained.

In all the NARS institutions, especially in the agricultural colleges, the number and quality of technicians and other support staff (laborers, clerks) are insufficient because of budget constraints and their extremely low salaries which discourage good candidates. This situation is a strong limiting factor for the scientists' research efficiency.

### **3.2 Physical Resources**

The NARS is endowed with a large number of locations and experiment stations (around 40 including college farms, within a total area close to 5,500 ha), scattered throughout the country (with a large concentration around Tunis). Their maintenance costs are all the more very expensive since their good management should require an actual regionalization of motivated scientific staff and a much larger number of technicians.

The current objective of IRESA is to reduce the number of stations belonging to its ARIs, leaving one principal station and two substations per agroecological region.

In the IRESA ARIs, the other physical resources have been renovated or enlarged recently, thanks to the World Bank loan. Conditions are much less favorable in the other NARS institutions.

### **3.3 Financial Resources**

The NARS total AR financial resources in 1996 were estimated at D (or US\$) 15 million (Table 1), of which: 12.8 million came from national sources (public budget and few institutions' self-generated resources), 1.8 million from the World Bank loan, and 0.4 million from external funds secured through bilateral or multilateral grants provided by few donors.

The NARS national and total resources amounted to around 0.53 and 0.63%, respectively, of the Agricultural Gross Domestic Product (AGDP estimated at D 2.4 billion in 1996); such ratios are rather low compared with the 1% ratio recommended by most international organizations.

One major issue is the level and origin of the OCC in the NARS institutions. At the IRESA ARIs, OCC is estimated (see Section 2.2) at D 29,000 per pRY, of which 40% is funded by external sources. All the other institutions which are less endowed, have OCC per pRY that is mainly funded by the state budget and ranges from around D 10,000 to 19,000 (IRA), which are under the "optimal" amount of about US\$ 25,000 to 30,000 per RY used in the long-term plans elaborated by many developing countries. According to this last reference, the Tunisian NARS may total around 200 actual RYs (aRYs), which means that the AR national scientific potential is not fairly mobilized. This situation should be worse without the investment resources made available by the World Bank loan.

Since 1985, before which the NARS enjoyed satisfactory financial resources (see ISNAR, 1987), the evolution has been negative. Taking into account inflation during the period 1986–1996 (around 185%) and the fast growth of the AGDP (almost 60% more in 1996):

- The national and external resources have strongly decreased in real terms: the national funds have dropped from D 10 million in 1985 (equivalent to 18.5 million in 1996 current D) to D 12.8 million in 1996, and the external funds from D 2.4 million in 1985 (equivalent to 4.5 million in 1996 current D, fully secured by grants) to 2.2 million in 1996 (of which only 0.4 million were grants);
- The NARS national and total resources represented 1.15 and 1.5%, respectively, of the AGDP in 1985, against 0.53 and 0.63% in 1996, which means a strong decrease in the relative efforts directed to AR.

## **4. RESEARCH ACTIVITIES**

### **4.1 Research Orientation**

Since 1992, IRESA has identified eleven priority-oriented research programs (crop production, animal husbandry and pasture, fruit production, olive, vegetables, potato production, water use, agricultural mechanization, forestry, agriculture and desertification in the arid zones) and set up corresponding committees<sup>1</sup> (which include researchers, teachers from agricultural academic institutions and agronomists from various development sectors), which deal with

<sup>1</sup> Four fisheries research projects have been also targeted: stock evaluation and identification of new resources, biological studies of marine environment and pollution control, sea products evaluation, and fish farming.

monitoring and evaluation, as well as extension of new technologies developed. These Committees have improved to a certain extent the global management of the NARS; however, they do not cover all the AR fields in a balanced way, they are not fully operational (no monitoring and evaluation of activities is currently practiced), and they have not been able to bring research and academic institutes closer together through financing common research projects (instead of financing the institutions themselves) as expected.

Research programs are generally relevant to the national research objectives, but most of them do not have the critical mass of researchers needed for insuring scientific efficiency, and multidisciplinary projects are rare. It is currently difficult to assess whether their resources are well balanced with regard to the research needs of the agricultural sector. An assessment of the Committees and of the whole national research program is in course.

## 4.2 Linkages and Collaboration

### Linkages between the NARS Institutions

IRESA ensures coordination of research activities and cooperation, and seeks complementarity between research and education institutions at the national level and regional level (through the regional development poles). However, in reality, the director of research in IRESA, who should coordinate all research activities, deals only with ARIs, and cooperation is more often influenced by personal relationships. Linkages with the national universities are very poor.

### Relations with Development

Cooperation with development agencies has been improving. Linkage mechanisms that made informal collaboration possible are of different types, including short-term training, field days, joint research programs, research contacts, utilization of libraries and databases, use of laboratories and research stations, and joint publications and reports. The most innovative one has been the establishment of seven “regional development poles” for research (one per large agroecological zones), which offer a good framework for bringing together all partners in research at the regional level, including development agencies<sup>1</sup> and farmers’ representatives (Agricultural Unions, Chambers of Agriculture, Interprofessional Groupings, etc.). But these poles are not fully operational because of the very weak permanent presence of research staff regionally.

Technologies elaborated by the NARS that have been successfully adopted include improved cultivars of cereals, legumes, vegetables and fruit trees; biological and chemical control of plant diseases; better utilization of annual feed resources; and improved local sheep breeds. However, it is difficult to find data for an inventory of research output, or to evaluate the research impacts on agricultural development. This aspect may be explained by the lack of research output evaluation.

The technologies generated appear to be more readily adopted by large-scale farmers, agricultural development agencies, rural development societies and state and cooperative farms, rather than by the majority of medium- and small-scale farmers (Chennoufi and Neftoui, FAO, 1996).

### International Scientific Cooperation

All agricultural research and training institutions had in the past very strong relations with the international scientific community, both at the institution and scientist levels. During the last decade, these relations have been diminishing and changing from assistance to collaboration. Working relationships with international AR centers (including exchanging information, visits and plant material) remain good, especially with ICARDA. Bilateral relations are now rather weak, but collaborative research programs funded by the European Union are developing. It is worth noting that junior scientists who represent more than 50% of the total staff body of some institutions are working on higher degrees at foreign international universities.

## 5. CONCLUSION

The Tunisian NARS has been rather dynamic during the past years. A major achievement has been the creation within MOA of IRESA which currently maintains 67% of the pRYs and 87% of the total financial resources of the NARS. This structural improvement has led to many achievements, such as the grouping of some AR institutes, the

<sup>1</sup> Including the *Agence de la Vulgarisation et de la Formation Agricole*, set up to strengthen technology transfer and extension, as well as upgrade competence through training of technical support staff; the MOA Regional Development Bureau (*Commissariats Regionaux de Développement Agricole* or CRDA); and Regional Organizations for Agricultural Development (*Offices*).

setting up of programming committees which have improved priority setting and project formulation, the creation of regional development poles for improving links between research and development, and the valuable results obtained in cereals, food legumes, forages, vegetables and fruit breeding programs which have been widely adopted by farmers.

However, the NARS is still suffering strong weaknesses, such as the coordination between its institutions and the coordination with the other NARS institutions; the extreme concentration of the NARS scientific potential in and around Tunis; the high number of experimental farms with insufficient human and financial resources; the bureaucratic financial procedures; the not fully operational mechanisms for setting priorities, planning, monitoring and evaluation of research activities; and the mechanisms of valorization of research results which have not been sufficiently improved.

## Main Acronyms

**MOA**: Ministry of Agriculture. **MES**: Ministry of Higher Education. **SERST**: Secrétariat d'Etat à la Recherche Scientifique et à la Technologie. **IRESA**: Institution de la Recherche et de l'Enseignement Supérieur Agricoles.

**ENMV**: Ecole Nationale de Médecine Vétérinaire. **ESAK**: Ecole Supérieure d'Agriculture du Kef. **ESAMo**: Ecole Supérieure d'Agriculture de Mograne. **ESAMa**: Ecole Supérieure d'Agriculture de Mateur. **ESHE**: Ecole Supérieure d'Horticulture et d'Elevage de Chott-Mariem. **ESIAT**: Ecole Supérieure des Industries Alimentaires de Tunis. **ESIERM**: Ecole Supérieure des Ingénieurs et de l'Équipement Rural de Medjez El-Bab. **INAT**: Institut National Agronomique de Tunis. **INRAT**: Institut National de la Recherche Agronomique de Tunisie. **INRGREF**: Institut National pour la Recherche en Génie Rural, Eaux et Forêt. **INSTM**: Institut National des Sciences et Techniques de la Mer. **IO**: Institut de l'Olivier. **IRA**: Institut des Régions Arides. **IRVT**: Institut de Recherche Vétérinaire de Tunis. **ISPT**: Institut Sylvio Pastoral de Tabarka.

**D**: Tunisian dinar.

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Table 1 - The National Agricultural Research System (1996\*)

a. Except for IRESA human resources (1997) *Italics*: Approximate data --- Data not available. \* See footnotes

NARS Institutions				AR Scientific & Techn. Graduate Staff (Units)			Priority Res. Years		Total Budget (\$1000 D)		AR Expendit-Resources (R) (\$1000 D)				
No.	Name - Acronym Head Office - Year Established	Mandates * AR Fields	Govern. Minist./Body	Total	Non-Res.	Exp.	Nat.	Exp.	Nat.	Ext.	Nat.	Loan	Gr.	Total	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1.1	Institut Nat. Rech. Agronom. de Tunis, Tunis	INRAT 1913/81	AR (85%) - All (except 2.1/2.6)	86	20	75	3300	320	3050	810	110	1770			
1.2	Inst. Nat. Rech. Gén. Rural et Forêt, Tunis	INRGREF 1959/96	AR (85%) - Water res./marine forest	40	5	34	1960	590	1810	590		2400			
2.1	Institut de l'Olivier, Sfax	IO 1981	AR (85%) - Olive, pasteuriz., oleomels	25	4	21	890	170	620	170		990			
2.3	Institut de la Vigne - Vain de Tunis, Tunis	IVT, 1917/1970	AR (25%) - Animal product/health	17	1	3	510	70	30	30	30	120			
2.4	Total IRESA Research Institutes			168	30	160	7070*	1550	6060*	1370	140	7570			
2.5	Institut des Régions Arides Modernes	IRA 1976	AR (85%) - And more	43	0	43	37	2160	50	2180	50	2230			
2.6	Inst. Nat. Sc. Techn. de la Mer Sidi-Bachir/Tunis	INSTM 1924/1996	AR (85%) - Fisheries	63	5	30	55	1080		980		980			
1.2	Total 6 Agricultural Research Institutes			276	35	173	0	223	0	10490	1600	9220	1370	198	10780
3.1	Institut National Agronom. de Tunis, Tunis	INAT, 1889/1970	AHE - (AR) - All	105	48				2600						
3.2	Ecole Nat. Médecine Vétérinaire, Sidi-Thabet	ENAV, 1974	AHE - (AR) - Animal prod./health	47	15				1220						
3.3	Ecole Sup. Horic. et Elevage, Chott-Mariem	ESHE, 1975	AHME - (AR) - Vegetables	52	20				1450						
3.4	Ecole Sup. d'Agriculture, Le Kef	ESAK, 1976-83	AHME - (AR) - Field crops/animals	20	9				950						
3.5	Ecole Sup. d'Agriculture, Mateur	ESAMA, 1976	AHME - (AR) - Animal prod.	27	7				820	710	1500	400	250	2150	
3.6	Ecole Sup. Ingén. Equip. Rural, Medjez El-Bab	ESIERM, 1976	AHME - (AR) - Irrig. machin.	42	7				790						
3.7	Ecole Sup. Industri. Alimentaires, Tunis	ESIAT, 1985	AHME - (AR) - Food technology	21	7				640						
3.8	Ecole Sup. d'Agriculture, Moghrane	ESAMo, 1981	AHME - (AR) - Ag. economics	36	9				800						
3.9	Institut Sylvio-Pastoral, Tabarka	ISPT, 1970	AHE - (AR) - Agroforestry	12	6				300						
3	Total 9 Agricultural "Colleges"			362	128	200	0	91	0	10050*	710*	1600*	400	250	2250
4.1	Inst. Nat. Nutrition Technologie Alim., Tunis	INNTA, 1966	R - AR (45%) - Food technology*	16	4	10	0	16	0	1850		850		850	
4.2	Centre de Biotechnologie, Sfax	CBS, 1988	R - AR (25%) - Biotechnology*	5	2	3	0	5	0			250		250	
4.3	Inst. Nat. R.ch. Sci. Tech., Borj Cedria	INRST, 1980	R - (25%) - Divers.												
4.4	Univ. Tunis, Sfax, ...		AHE - R (AR) (25%) - Divers*	60	30	20	0	15	0			200		200	
4	Total Other Scientific Institutions			81	36	43		38	0			1300		1300	
5.1	Bur. Inventaire et R.ch. Hydrologues - Tunis	BRH (1981)	AD - (AR) - Water resour. manag.	30	3	7	0	8				350		350	
5.2	Direction des Sols - Tunis	DS	AD - (AR) - Soil	11	4	5	0	3		820		120		120	
5.3	Centre Nat. d'Etudes Agricoles - Tunis	CNEA (1973)	AD - AR (30%) - Ag. economics	17	2	0	0	5		800		240		240	
5.4	Centre Nat. de Télédétection, Tunis	CNT (1988)	D - AD - AR ( % ) - Remote sensing				0								
5	Total Other Non-Scientific Institutions			58	9	12	0	16	0			710		710	
6	Total NARS			777	208	428	0	368	0			12830	1770	440	15040
Exchange Rate: US\$ 1 = 1 Tunisian dinar (D) (1996 average rate)				Actual Res. Years (aRYs) (Estimate) -->			200	0	AR Expendit. (million US\$) -->		12.8	1.8	0.4	15	

MOA: Ministry of Agriculture; MES: Ministry of Higher Education; SERST: Secretariat d'Etat à la Recherche Scientifique et à la Technologie; IRESA: Institut de la Recherche et de l'Enseignement Supérieur Agronomes

\* Mandates: AR ( % ) Approximate average % of financial resources devoted to ag. research (AR); AHE: Ag. higher education; AHME: Ag. higher and medium level education; AD: Ag. development/services (for AR and AHE institutions seed production, and analysis, extension, studies, etc.)

\* Notes: 2.4) and 2.4) ARs total = 5% for management cost of the Directorate IRESA 3.4) including D 310 million from grants (150 to INAT, 110 to ESHE, 50 to ESER), and 0.4 million from the World Bank loan 3.5) and 3.6) Colleges total = 5% for management cost of the Directorate IRESA 4.1, 4.2, 4.4 Only data/estimate of the AR human and financial resources

National AR expenditures (NE) = 0.53% of the Agricultural Gross Domestic Product (AGDP = US\$ 2.4 billion in 1996); Total AR expenditures (TE) = 0.63% of the AGDP

5. MONOGRAPHS OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEMS OF THE NILE VALLEY  
AND RED SEA REGION

EGYPT

ERITREA

ETHIOPIA

SUDAN



# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF EGYPT<sup>1</sup>

## 1. HISTORICAL BACKGROUND

The first school of agriculture in Egypt was established in 1869 and the first directorate of agriculture in 1875. During the 19th century, **agricultural research** (AR) was carried out by the Egyptian Royal Society, and as early as 1897, a number of experimental farms were established at various locations. In 1910, the Agricultural Authority was established under the Ministry of Public Works; it was responsible for conducting research and producing seed, extending methods to farmers in crop production, especially cotton, analyzing soil and fertilizers, controlling pests, and producing scientific and technical publications. A royal decree established the Ministry of Agriculture (MOA) in 1913. Following that, decrees were issued to organize research bodies and to coordinate between them and the farmers. For that purpose, the Cotton Research Council was created in 1919 and included plant, chemistry and pest experts in cotton. The Council offered services to Egyptian agriculture and paved the road for various field crop research endeavors. The formation of the Technical Research Committee in 1928 was the beginning of technical coordination and organized recording of research between the different MOA departments.

A presidential decree issued in 1957 represented the cornerstone for scientific research. The decree stated that research departments were to be formed within the different ministries and government agencies. Among the first departments within MOA were Plant Breeding, Horticulture, Chemistry, Entomology, Agricultural Education, Veterinary Medicine, and Agricultural Inspection. Ministerial offices opened in various regions of the country.

MOA has undergone several dramatic reforms in the past decades. It has grown from only seven major departments in 1913, and 28 in 1950, to 194 in 1963; 92 of these dealt with various aspects of agricultural production. Among the major departments were Agriculture, Horticulture, Plant Protection, Soil, Animal Production, Veterinary Laboratories and Seed Production. These research departments were reorganized in 1971 into one research body within the Ministry of Agriculture and Land Reclamation named the General Authority for Agricultural Research, which was later (1983) renamed the Agricultural Research Center (ARC), and evolved as the major institution for agricultural research and extension in Egypt.

In 1939 the Desert Institute was established to explore the desert and evaluate and develop its rich natural resources, and was officially inaugurated in 1950. In 1990 the institute became the Desert Research Center (DRC), and with its new name, it acquired new structures, laws and bylaws. During its early period, the institute operated under several authorities and organizations, including the Permanent Council for National Production, the National Research Center, the General Agency for Desert Rehabilitation, the Ministry of Scientific Research, the Ministry of Land Reclamation, and, finally, the Ministry of Agriculture and Land Reclamation (MALR).

Research in oceanography and fisheries began with the Alexandria Institute of Hydrobiology, established in 1927 by the Ministry of Agriculture, and the Red Sea Branch of the University of Cairo (1932). The Institute of Oceanography and Fisheries (IOF) merged these two units in 1962, added a new branch specialized in inland water and aquaculture (1967), and was renamed in 1986 as the National Institute of Oceanography and Fisheries (NIOF).

**Agricultural higher education** (AHE) started in Egypt in the first half of the nineteenth century by establishing higher institutes in several fields including agriculture and veterinary science. Although the first university was established in Cairo in 1908, it did not incorporate agriculture in its programs. In 1935 its name became the Egyptian University, then Cairo University, and, at that time, was expanded to include agriculture. Later, university education in agriculture grew: Alexandria University was established in 1942, Ain Shams in 1950, and many others over the years. As of 1996, there were 28 faculties of agricultural sciences (18 faculties of agriculture, 8 faculties of veterinary medicine<sup>2</sup>, and 2 institutes for agricultural cooperation training) throughout the country, the last of which (Faculty of Agriculture, South Valley University) was established in 1996.

Other institutions include AR departments/units. The National Research Center (NRC) was established in 1956 as a governmental program for conducting theoretical and applied research in natural sciences, and passed through several stages of development, with the inclusion in 1968 of all AR under a food and agriculture program and from 1973 higher emphasis given to orienting research activities to serve the specific needs of national end users. The Water

<sup>1</sup> By **Dr Saad Nassar**, Director, Agricultural Research Center, **Dr Abdel Wahab Abdel Hafez**, former President, Ain Shams University, and **Dr Hala Hafez**, Consultant, ICARDA.

<sup>2</sup> At the time of finalizing this monograph, three new faculties of veterinary medicine had been established (Mansoura, Menoufia and South Valley/Qena); however, it was too late to include information related to them.



Research Center (WRC), which was created in 1975, was reorganized in 1994 as the National Water Research Center (NWRC). The Atomic Energy Authority (AEA), which was established in 1955, has now four centers, of which two (the Nuclear Research Center and the National Center for Radiation Research and Technology, established in 1955 and 1972, respectively) include AR departments.

In this historical overview of the NARS, it is worth to mention:

- the implementation of the National Agricultural Research Project (NARP), funded by USAID from 1985 to 1995, which integrated the different AR institutions (ARC, faculties of agriculture, DRC, NRC, AEA and the private sector), provided huge grants (see Section 3.3) for human resource development, capacity building, interdisciplinary and collaborative research through local and international linkages, and initiated institutional reforms; and
- the establishment by MALR in 1992 of the National AR Council (NARC) and four regional agricultural research and extension councils (affiliated to this National Council), which are responsible for setting up the AR policy at the national and regional levels, respectively.

## 2. THE CURRENT NARS

### 2.1 Overview (see Table 1)

The **public** NARS currently includes a large number of scientific institutions within different ministries which may be grouped into three main categories:

- The institutions mainly involved in AR: the Agricultural Research Center (ARC) and the Desert Research Center (DRC) within the Ministry of Agriculture and Land Reclamation (MALR), and the National Institute of Oceanography and Fisheries (NIOF) within the Ministry of Scientific Research and Technology (MSRT); they gather around 3800 potential research years (pRyS or equivalent full-time researchers), i.e., 57% of the pRyS, and 77% of the total financial resources of the NARS. These institutions are presented in Section 2.2.
- The 18 faculties of agriculture (FA) and 8 faculties of veterinary medicine (FVM) affiliated to the Ministry of Education: they meet around 22% of the pRyS and 6% of the financial resources of the NARS (see Section 2.3).
- The “other NARS institutions” in which AR activities cover a more or less small part of their mandate: the National Research Center (NRC), the National Water Research Center (NWRC), the Atomic Energy Authority (AEA), and diverse faculties/universities: these institutions affiliated to different ministries meet the remaining resources of the NARS (21% of the pRyS, 17% of the funds) (see Section 2.4).

Since 1992, the National Agricultural Research Council (NARC)<sup>1</sup> has had the mandates at the national and regional levels (see Section 4.3) for (i) designing the general policies for AR plans, programs and projects in different research disciplines, (ii) investigating methods for funding and supporting them, and (iii) integrating and coordinating between them, and monitoring them. Since the creation of MSRT and NARC, the Academy of Scientific Research and Technology (ASRT), established in 1971 for strengthening scientific research and technological development in the country through diverse activities<sup>2</sup>, does not have a significant role in the governance of the NARS.

The **private sector** is increasingly getting involved in AR, particularly that dealing with seeds, tissue culture, and agrochemicals; however, no precise information is available on the related activities and resources. The private American University in Cairo has a Desert Development Center (established in 1985), with some research on sustainable development of the desert (conducted on an area of 240 ha northwest of Cairo in addition to an area of 12 ha near Cairo where the Center is located).

<sup>1</sup> Composition of the Council: Chairman: the Minister of Agriculture; rapporteur: the Director of the ARC; members: Director and Deputy Directors of the ARC; Presidents and Deputies of the agriculture universities; Director of the NWRC; representatives of the Academy of Scientific Research and Technology (ASRT) (Chairman, Head of the Food, Agriculture and Irrigation Research Council, and Head of the Animal Wealth and Fisheries Research Council); NRC (Chairman), and DRC (Director); Consultants to the Minister of Agriculture; Head of the Extension Sector of MALR; and 4 representatives of non-governmental universities and the agricultural private sector.

<sup>2</sup> Such as defining priorities for research of major development areas; formulating policies that strengthen linkages between science and technology organizations; procuring financial support to priority research programs; organizing state scientific awards; supporting scientific societies; etc. These activities were guided by a broad-based Council, with the support of 14 specialized councils, including the Food, Agriculture and Irrigation Research Council and the Animal Wealth and Fisheries Research Council.

**Outside the NARS**, Egypt is hosting regional bases of some international agricultural research centers (CIP, ICARDA<sup>1</sup> and ICLARM), which are also involved in the collaboration among Egypt and other countries. FAO has its Near East Office in Giza.

## **2.2 The AR Institutions**

### **The Agricultural Research Center (ARC)**

#### Mandate and Organization

ARC is the largest institution of the NARS (around 47% of its pRYs and 61% of its financial resources). It is an autonomous institution governed by a Board of Directors, chaired by the Minister of Agriculture, and composed of the director and deputy directors of ARC, directors of the research institutes, three eminent professors from the universities, the chairpersons of NWRC and NRC, and one representative of the private sector.

In addition to the Directorate for General Administration and Financial Affairs, ARC has three directorates which are in charge of the main mandates: the Directorate for Research which oversees the 24 semi-autonomous research institutes and central laboratories (see below); the Directorate for Extension (see below: relations with development), and the Directorate for Production, responsible for the management of the research stations and ARC state farms (totaling 12,600 ha), primarily devoted to the production of foundation seed of major crops.

#### ARC Research Units

ARC activities are implemented by 24 semi-autonomous units: 16 research institutes (RIs) and 8 central laboratories (CLs) listed in Table 2, which cover all fields, except marine fisheries, and present very different profiles as follows:

- Their mandate: AR mobilizes between 20 and 100% of the time of the graduate scientific and technical staff of the research units, with an ARC average of 56%; the remaining time is allocated to development, extension or technology transfer, and to education activities (lectures at the faculties of agriculture and faculties of veterinary medicine; support to graduate students; training for extension personnel). Most of the units carry out basic, applied and adaptive AR, with more emphasis on basic or "high-tech" research in some of the relatively recent and considerably innovative units, e.g., the Agricultural Genetic Engineering RI (74 graduate staff members, gsm) and Agricultural Expert Systems CL (17 gsm).
- Their size according to their human and financial resources: the largest RIs have more than 500 gsm (Horticulture RI: 748 gsm; Soil, Water and Environment RI: 610 gsm; Field Crops RI: 581 gsm; Plant Protection RI: 542 gsm), and the smallest ones less than 50; total budgets (1996) vary from LE 0.5 million (US\$ 0.15 million) to 24.4 million (US\$ 7.2 million for the Animal Production RI).

#### ARC Human, Physical and Financial Resources

The 24 ARC research units have a total of about 5,620 graduate scientific and technical staff members (2,700 PhD, 1,400 MS and 1,520 BS holders)<sup>2</sup> who represent 3,140 pRYs<sup>3</sup>. Continuous efforts are being exerted to upgrade staff qualifications; during the period 1981–1993, ARC scientists obtained 1,607 MS and 1,441 PhD degrees prepared at Egyptian universities, and 20 MS and 90 PhD degrees prepared abroad through NARP, in addition to 2,150 post-doctoral and other training opportunities provided by the same project.

The graduate staff is unevenly distributed among the different regions. Most are concentrated at the institute headquarters in Cairo (4,693 = 83.5%) and in the regional stations in the Delta (700 = 12.5%), an area which represents 51.3% of the irrigated area of the country. The others are in Middle Egypt (111 = 2%) and Upper Egypt (113 = 2%), which have respectively 16.1 and 14.1% of the national irrigated area.

<sup>1</sup> The ICARDA regional office, established in Cairo in 1979, oversees the Nile Valley and Red Sea Regional Program (NVRSP) which includes national scientists from Egypt, Sudan, Ethiopia and Yemen, and covers research on food legume crops, cereals and natural resource management.

<sup>2</sup> Through diverse activities, such as production of seeds and vaccines; services (biological, chemical analysis; soil mapping; studies, consultancies; etc.); and backstopping for extension institutions in the form of technical support and publications, recommendations, on-farm trials and demonstration.

<sup>3</sup> ARC totals 37,300 permanent employees, including the 5,620 graduate scientific and technical staff mentioned above, 15,800 research support degree holders and 16,900 support-service staff (administrators, technicians and workers).

<sup>4</sup> Calculated from pRYs = number of the ARC graduate scientific and technical staff × 55% (approximate overall average % of their time devoted to AR).

The 15,800 technicians and 16,900 other support staff members (clerks, laborers, etc.) are considered sufficient or, rather, in excess (2.8 and 3 per graduate scientific and technical staff member, respectively).

ARC operates 10 regional research stations throughout the country, to which 37 specialized subregional research and trial stations belong, of these stations, 22 possessing a total land area of about 1,500 ha are distributed all over the different governorates. Physical facilities are unevenly distributed: thanks to NARP, labs and offices located at the headquarters of the institutes (especially the newly established ones) and 19 research stations are in good condition and are rather well equipped (US\$ 32 million invested); and a very modern library (the Egyptian National Agricultural Library, ENAL) was established in 1995 in Giza, serving ARC and all MALR services. ENAL fully utilizes computerized information storage and retrieval systems, electronic network, etc. (cost: US\$ 6.3 million).

In 1996, the total direct financial resources of the 24 research units amounted to around LE 163 million (US\$ 48 million), of which about LE 140 million were from a national origin (mostly MALR annual budgetary allocation) and the remaining from grants secured by numerous bilateral and multilateral donors, the major ones being the USA (about 50%), European Union (about 10%), the World Bank (about 10%), European countries, Canada, Japan, FAO, IFAD and UNDP. These grants have dramatically decreased since the completion of the US-funded NARP in 1995 (see Section 3.3). In addition, the financial resources of the general ARC administration related to the research units may reach some LE 16 million. Total AR expenditures are roughly estimated at LE 143 million (see Table 2), of which around LE 72 million are in salaries and 71 in operating and capital costs (OCC<sup>1</sup>); this means an average OCC amount of LE 22,600 (US\$ 6,600) per pRY, which is rather low and far from matching the financial research needs (see Section 3.3).

### Research Activities and Linkages

ARC is implementing its fourth research plan (1997/98-2001/02) which is guided by the strategy for agricultural development, in line with what has been accomplished during the previous research plans. This plan, as the others, has been prepared and is implemented closely with the other national institutions and scientists associated with the ARC programs. It carries out a 13-program national AR plan encompassing all areas of agricultural production.

Relations with development are structurally organized: the ARC Directorate for Extension is technically responsible for the Central Administration for Agricultural Extension (CAAE), which supervises the activities of the MALR extension service<sup>2</sup>. They have been recently improved after the creation of the regional research and extension councils and the establishment of the national campaigns for commodities (see Section 4.3).

ARC has set up a dense network of external scientific relations, particularly with some AR international centers (IRRI, ICARDA, CIMMYT, CIP, IPGRI, IIMI, IFPRI, ICRISAT and ICLARM) and with scientific organizations of developed countries (USA, EU, European countries, etc.). It also plays a major role in regional training and research activities with Middle Eastern, African, and Asian countries.

### **The Desert Research Center (DRC)**

DRC activities are devoted primarily (around 70% of its resources) to research for the development of the desert and newly reclaimed areas. Other activities cover development, extension and services, especially through its "private service unit" involved in surveys (underground water, soils), chemical analyses (water, soils), feasibility studies, etc.

DRC is composed of four divisions, which demonstrates the large spectrum of its research fields:

- Water Resources and Desert Soils (with 9 departments, including Geophysical Exploration, Renewable Energy, Hydrology, Pedology, Soil Fertility and Microbiology, Soil and Water Conservation, etc.);
- Ecology and Dry Land Agriculture (with 6 research departments, including Genetic Resources, Plant Production, Plant Ecology and Range Management, Sand Dune Fixation, etc.);
- Animal and Poultry Production (with 5 research departments, including Animal and Poultry Breeding, Animal and Poultry Nutrition, Animal and Poultry Breeding Physiology, etc.); and
- Socioeconomic Studies (with 3 research departments, including Agricultural Economics, Agricultural Extension,

<sup>1</sup> Estimate based on two reasonable hypotheses: (i) the distribution of the national expenditures in the research units is the same as for the whole ARC (1996 total resources, including the production sector, extension, central administration for regional research stations, and general administration: LE 232 million, of which 135 million [58%] are in salaries and LE 97 million [42%] in operating and capital costs); and (ii) the external grants are essentially directed to operation and capital costs.

<sup>2</sup> CAAE is administratively affiliated to MALR; it employs more than 22,000 extension specialists in various fields of agriculture, distributed at village, district and governorate levels.

etc.).

It also has three associated units: the Tissue Culture Laboratory, the Geo-Information Systems Center, and the Satellite Receiving Station.

DRC has 1,093 permanent staff, of whom 327 are researchers (183 PhD, 84 MS and 60 BS holders), while another 341 graduates with BS assist in research. There are 108 technicians, 193 administrative staff and 124 laborers. DRC has 70 laboratories, 4 experimental stations, and 4 smaller field stations located throughout Egypt to serve the local farming communities. In general, physical facilities (labs, equipment) are moderate, except in some units that are well endowed (such as the three associated units established in the 1980s and 90s: the Tissue Culture Laboratory, the Geo-Information Systems Center, and the Satellite Receiving Station).

The total budget of DRC amounted to LE 23.8 million (US\$ 7 million) in 1996, mostly from national sources (LE 23 million), with actual salaries being LE 9 million and OCC LE 14.8 million. AR expenditures are estimated at LE 20.7 million (see Table 1), of which around LE 7.8 million are in salaries and LE 12.9 million in OCC; this means an average OCC amount of LE 56,000 (US\$ 16,500) per pRY.

The Center has been collaborating with a large number of national, foreign and international scientific organizations and development organizations. However, funds provided by France, Germany, the European Union, and ACSAD are currently relatively limited (LE 0.8 million).

### **The National Institute of Oceanography and Fisheries (NIOF)**

NIOF is mandated with maintaining and developing water bodies and their natural resources; proposing measures for the protection of the aquatic environment; and organizing, conducting and supervising research on fisheries, freshwater aquaculture, mariculture and seafood technology for the better management of the country's aquatic resources. Applied research to address national and regional problems is the main activity of the Institute.

NIOF is organized in four divisions (Oceanography and Marine Ecology; Aquaculture; Fisheries; and Freshwater and Man-Made Lakes) with a number of specialized, well-equipped laboratories. The scientific divisions and research laboratories are encompassed into four main branches (Mediterranean and Northern Lakes, Inland Waters, Suez and Aqaba Gulf, and the Red Sea), with nine field stations including fish farms and aquariums, throughout the country, with many more stations proposed for the future.

It has around 1,500 permanent staff, among whom 428 are graduate researchers (136 PhD, 132 MS and 160 BS holders). Its 1996 total budget (which also represents its AR expenditures since AR mobilizes 100% of NIOF's resources) amounted to LE 14.3 million (US\$ 4.2 million), of which LE 12.3 million were from national sources and LE 2 million from external grants, with salaries being LE 9 million and OCC LE 5.3 million, which means an average OCC amount of LE 12,400 (US\$ 3,600) per pRY.

NIOF has collaborative research programs and activities funded/supported by ASRT, Canada, USAID, UNEP, WHO and FAO.

## **2.3 The Faculties of Agricultural Sciences (FASs)**

### **Overview (see Table 3)**

Egypt has 18 faculties of agriculture (FAs) and 8 faculties of veterinary medicine (FVMs)<sup>1</sup>, designated later on as FASs. Teaching is their main mandate; research and extension activities are generally limited (see below). All FASs provide BS programs and most offer MS and PhD graduate programs; in addition, they often offer Diploma programs. The current (1997/98) number of undergraduate students enrolled in the FASs is 30,350, while graduate students are 8,060, of which 4,800 students are registered for MS and 3,260 for PhD programs<sup>2</sup>.

The FASs are within universities which are affiliated to the Ministry of Education. At the national level, they are run by the Supreme Council of Universities, consisting mainly of the university presidents, and chaired by the Minister

<sup>1</sup> Moreover, Egypt has 2 institutes for agricultural cooperation training (the Agriculture Cooperation Institute in Shoubra El-Kheima and the Cooperative Extension Institute in Assiut, established in 1960 and 1970, respectively), which are not engaged in AR, and only produce graduates who work in agricultural cooperatives in the different villages.

<sup>2</sup> In 1994, these numbers were: 28,170 undergraduate students, 4,824 graduate students (3,108 and 1,716 registered for MS and PhD programs, respectively).

of Education. The Council has an Agricultural Sector Committee<sup>1</sup> responsible for the overall FAS policy (curriculum changes, establishment of new FASs, initiation of special units, etc.). At the university level, a FAS is managed by the University Council, chaired by the University President, which consists of all the deans of the different faculties and three vice-presidents (for research and graduate studies, for educational affairs and students, and for community affairs and environmental development). Every FAS is headed by a Dean, assisted by three deputies (homologous to the three vice-presidents of the University); the Dean chairs the Faculty Council<sup>2</sup>.

The FASs have a total of around 5,900 academic staff members (asm) (4,640 at the FAs and 1,250 at the FVMs), of whom 4,060 are PhD holders, 750 MS and 1,080 BS holders, most of them preparing higher degrees. They represent around 1,470 pRYs<sup>3</sup>.

The most important FASs are generally the oldest: the FAs of Cairo University in Giza (868 full-time academic staff members, asm), Ain Shams University in Cairo (499 asm), Alexandria University in Alexandria (498 asm), Zagazig University (475 asm), and the FVM of Cairo University in Cairo (334 asm). The most recent ones are also the smallest; they are the FAs of Suez Canal University in El-Arish (31 asm), Alexandria University in Damanhour (34 asm), Tanta University in Tanta (45 asm), and South Valley University in Sohag (19 asm).

The FASs are unevenly distributed among the regions: 20 out of the 26 faculties are in Cairo, the Delta and surroundings, where most of the academic staff (about 84%) are located.

#### **Research Activities** (Hamdi and Sabbah, FAO, 1996)

Research at the FASs is currently carried out by three categories of researchers, namely the staff members (PhDs), the assistant staff, and the graduate students. Except for the graduate students who are preparing their MS or PhD theses, a good number of staff members are reluctant to conduct sustainable research, especially those who have become professors. This is probably due to a combination of factors, including:

- A general feeling that the main role of the staff member is teaching;
- The lack of team-work, as single-author publications are given more credit when assessing possible promotion, and this leads to young researchers wishing to work individually rather than as part of a team;
- The lack or inadequacy of national research funding for the professors and the graduate students<sup>4</sup>;
- The lack of skilled technicians; and
- The lack of coherent policies for AR.

Accordingly, the percentage of human and financial resources allocated to AR activities does not actually exceed 10%. However, MALR and ARC have been exerting great efforts to involve university scientists and graduate students in national research programs, especially through NARP (in the period 1985–1995). Moreover, joint research and collaborative links with AR institutes (ARIs) are numerous: ARI researchers undertake graduate studies at the universities; ARI directors are members of the Faculty Councils; deans and professors participate in the governing bodies of the ARIs and also participate with ARI leaders in the regional agricultural research and extension councils and the commodity campaigns (see Section 4.3), etc.

#### **2.4 The Other NARS Scientific Institutions**

AR activities generally cover a more or less small part of the mandate of these “other NARS institutions.” They are mainly the National Research Center (NRC), National Water Research Center (NWRC), and Atomic Energy Authority (AEA), affiliated respectively to the Ministries of Scientific Research and Technology; Public Works and Water Resources; and Electricity and Energy.

<sup>1</sup> This committee is composed of deans of the FASs, university presidents and vice presidents with agricultural backgrounds, a number of First Deputy Ministers of Agriculture and a number of senior, usually emeritus, professors of agriculture.

<sup>2</sup> This Council consists of the chairpersons of the academic departments and a professor from each department in rotation, the three faculty deputies, two associate professors and two assistant professors, in addition to five distinguished professors from the faculty members and three eminent personalities from outside the faculty, to be nominated by the Faculty Council and approved by the University Council.

<sup>3</sup> Based on the normative percentage (adopted for all the study) of 25% of the time of the academic staff members potentially allocated to AR activities (pRYs = number of asm × 25%).

<sup>4</sup> For example, the funds allocated for research in the FA, Alexandria University, in the academic year 1993/94 was only LE 15000, to be shared among 436 faculty members and 103 support staff i.e., about LE 30 per member per year for research.

### The National Research Center (NRC)

NRC consists of 59 departments grouped into 13 divisions, four of which carry out research related to agriculture and mobilize together important human and financial resources (see Table 4).

- Two of these divisions specialize totally in AR: the Agricultural and Biological Research Division (botany, plant protection, soil and water, animal production, animal diseases, field crops, horticulture, etc.), which is one of the largest of all the 13 divisions, with its research staff (580 researchers, of whom 420 are PhD and 130 MS holders) representing about 25% of the total research staff of all the divisions; and the Food Industry Research Division (food and dairy industries, fats and oils, food and nutrition) (300 researchers, of whom 110 are PhD and 50 MS holders).
- The two others conduct AR besides other research activities: the Basic Sciences Research Division (microbial chemistry, flora and plant taxonomy, etc.) (200 researchers, of whom 120 are PhD and 60 MS holders); and the Genetic Engineering and Biotechnology Research Division (cellular biology, plant cell and tissue culture, etc.) (100 researchers, of whom 50 are PhD and 40 MS holders).

Agricultural field research facilities of the NRC include two research farms in the Delta and New Valley, four research stations in Cairo, Giza, West Delta, and the Red Sea region, and three pilot units in the NRC premises.

Activities of the NRC are not conducted on department or division basis, but rather on program basis and are multidisciplinary in nature. A large number of projects (138) are conducted under three programs: priority, development and basic research. Some projects, especially the one on optimizing fertilizer use on a national level, are conducted in collaboration with universities, ARC, a number of Arab countries, European countries, and international research and donor organizations (GTZ, IDRC, USAID, EU, CIP, etc.).

### The National Water Research Center (NWRC)

NWRC consists of 12 research institutes (RI) and a training center. Each institute conducts research in a specific field. Two of these institutes, the Water Management RI and the Drainage RI, deal directly with AR (see Table 4).

The Water Management RI: WMRI has 60 graduate scientific staff members (including 20 PhD and 15 MS holders) and 11 experimental research stations. It is engaged in research on crop water requirements, water distribution, water losses, on-farm irrigation, and water quality control. It carries out applied research programs on farmers' fields in three regions: the Delta, Upper and Middle Egypt, and Giza, which represents areas subject to urbanization. Several projects are implemented by the Institute, including one that is financed by the German Technical Cooperation Agency (GTZ).

The Drainage RI: Scientists at DRI (70 graduate scientific staff members, including 10 PhD and 25 MS holders) conduct research on different drainage systems and reuse of drainage water. One experimental field, 100 monitoring stations along the main drains in the Nile Delta and Fayoum, and a number of laboratories are dedicated to the institute's research. In addition to a number of national institutions, the institute cooperates with many international organizations in the Netherlands, the USA, Italy, the UK and Canada.

### The Atomic Energy Authority (AEA)

AEA is affiliated to the Ministry of Electricity and Energy and includes two centers involved in AR (see Table 4):

- The Nuclear Research Center has three agriculture departments within one of its four divisions (Radioisotope Applications Division): a soil and water department, a biological applications department, and a botany department, with 230 scientists (100 PhD, 60 MS, 70 BS);
- The National Center for Radiation Research and Technology has two agriculture departments within one of its three divisions (Radiation Research Division): a radiation microbiology department and a natural products department, with 100 scientists (40 PhD, 20 MS).

The departments are involved in research centering around the peaceful application of nuclear science and technology in agriculture, specifically on studies of soil, water, fertilizer, plant production (field, horticultural, and oil crops, and medicinal and aromatic plants), animal production, entomology, pathology, and the application of radiation technology to identify, evaluate, and reduce microbial toxins in food products and to evaluate the resistance of plant varieties to salinity, drought and viral diseases, etc. Research is conducted in a number of central labs and experimental farms. The departments have close cooperation with the International Atomic Energy Agency (IAEA) in Vienna and the National Science Foundation (USA), and have cooperative research agreements with institutions in Italy and Germany.

## Other University Units

A large number of university units (Faculties of Sciences with departments of biology; Faculties of Engineering; Faculties of Economics; Faculties of Arts or Education, with departments of geography; etc.; Higher Institute of National Health, with departments of microbiology, nutrition, etc.) have large numbers of highly qualified scientists in sciences related to AR in general (plant/animal biology, including breeding, pathology, entomology, microbiology; mechanization; food technology; human nutrition, rural economics and sociology; etc). A precise inventory of this potential is not available, but according to a rough survey, this number should reach at least 400 academic staff members (rough estimate), who should represent 100 pRYS.

## 3. AR RESOURCES

### 3.1 Human Resources

Graduate staff (see Table 1): About 14,300 scientific and technical graduate staff (all national) are working in the agricultural sciences in Egypt and represent around 6,700 pRYS; 39% of these scientists are working at ARC and 41% at the FASSs. Among them, 57% possess PhDs and 20% MSs. The FASSs have the largest number of the highest trained scientists (4,070 PhD holders, i.e. 49% of the total). Strong attention has been given in the last decade to upgrading the academic level of the scientists in all the NARS institutions.

Research staff at the research institutions (ARC, DRC, etc.) follow the same career scheme as at the universities, although the titles may differ. Salaries may appear rather low (LE 1,500 or US\$ 440 per month for a senior researcher with PhD; LE 600 for a researcher with MS), but scientists receive other incentives (extra academic load/teaching, supervision of postgraduate students, etc.), and a few (those working in the regional research stations or regional universities) are either provided with housing or housing allowance. Moreover, those salaries are relatively high in term of "parity revenue" (according to the cost of life).

Too large a proportion of the scientists are located in Cairo and the Delta region, amounting to around 96% for the ARC, 84% for the FASSs, and quite almost the same for the other NARS institutions. But as noted above, these regions represent about 51% of the irrigated area of the country and may contribute a similar proportion to the national Agricultural Gross Domestic Product (AGDP).

Other staff: In general, support staff numbers at the research institutes are satisfactory, with even excess of administrative and non-skilled laborers; but the FAS scientists suffer an acute lack of support staff. These categories of staff are much underpaid (LE 150 or US\$ 44/month for a technician or a secretary).

### 3.2 Physical Resources

In general, material resources of ARC are now good, partly due to NARP, which has contributed since 1985 to the renovation of many of the infrastructures/facilities of the institutes, central labs and research stations, and provided them with modern scientific/farm equipment, vehicles, information/communication services, etc.

DRC and NIOF have also rather good physical facilities, which have been in general funded jointly by the Government and external grants.

The other NARS institutions are far from being well endowed; however, some of the FASSs have received some funds from NARP for improving their facilities.

### 3.3 Financial Resources

In 1996, total funding amounted to around LE 230 million (US\$ 68 million), of which LE 207 million (US\$ 61 million) came from national resources (the Ministry of Treasury and the institutions' self-generated resources), and 23 million (US\$ 6.8 million) secured through grants provided by bilateral or multilateral numerous donors.

The national and total AR financial resources represent respectively 0.50 and 0.56% of the AGDP (US\$ 12.1 billion in 1996). With respect to 1985, national resources registered a high increase in absolute terms (almost 60% in US\$), and decreased in relative terms (compared to the AGDP)<sup>2</sup>. With respect to the last year, the completion of the huge

<sup>1</sup> They are much above the average income per capita in the country which amounts (1995) to US\$ 1070/year or US\$ 89/month (according to the official rate of exchange) and US\$ 3,850 in terms of "parity revenue" estimated by the World Bank.

<sup>2</sup> In 1985, the national AR financial resources were estimated at US\$ 40 million and represented 0.7% of the AGDP according to available incomplete data (Casas, CIHEAM, 1988).

NARP<sup>1</sup> resulted in a significant decrease of the NARS resources; during the fiscal year 1991/92, the estimated total resources of the NARS amounted to around 1.2% of the AGDP.

Areas of expenditure vary considerably between the institutions. As seen above, at ARC, salaries represent a little more than 50% of the total financial resources, and operation/capital costs (OCC) amount to LE 22,600 (US\$ 6,600) per pRY, which is only around 22–24% of the "optimal" amount of US\$ 25,000–30,000 per RY used in the long-term plans elaborated by many countries in similar agroecological conditions.

However, the capital costs (CC) currently needed are lower because of the large investments made under NARP, and considering that the CC represents around 30% of the OCC in the well-endowed ARIs, it is reasonable to estimate that the currently available OCC allows an actual employment of around 27–33%, which means that ARC actually has between 850 and 1040 actual RYs (aRYs), against 3,140 pRYs estimated above.

In the other institutions of the NARS, in general, salaries represent a higher proportion of the total resources, OCC per pRY are often much lower (except for DRC<sup>2</sup>), and recent investments have been relatively moderate or weak; this means that the ratios of actual employment are probably much lower than those estimated for ARC.

With ratios of actual employment between 15 and 20% for the other institutions, the whole NARS has (roughly) between 1,400 and 1,800 actual RYs (aRYs), against the 6,710 pRYs estimated above, which means that the AR scientific potential is actually far from being fully mobilized.

## 4. RESEARCH ACTIVITIES

### 4.1 Research Orientation

To overcome the challenges facing Egypt, in line with the agricultural development strategy aiming at optimizing crop yields per unit of land and water, and concentrating on increasing production, studying patterns of food consumption and reducing it, and minimizing production losses, effort was exerted at ARC in preparing the fourth five-year (1997/98–2001/02) research/extension/training plan. The plan focuses on adopting integrated and applied research programs together with extension and training programs, basically to develop new high-yielding cultivars and new technologies, and to find the most efficient methods for water use, and on the coordinated efforts of the different research institutes of ARC and other institutions for its implementation.

Based on the total number of researchers at ARC and NIOF, a breakdown of researchers between the large research fields and/or production branches indicates that about 41% are engaged in research on field and industrial crops, 24% on horticultural crops, 19% on animal production, and 16% on aquaculture/fisheries. With the FASs, these percentages may be more or less similar. From their comparison with the breakdown of the AGDP between the corresponding branches (field and industrial crops: about 40% of the AGDP; horticultural crops: 28%; animal production: 28%; fish production: 4%), it can be deduced that research on animal production (which generally demands more resources than research in other branches) is under-emphasized, and fish research over-emphasized.

There is a lack of a permanent unit (research institute) on farming systems at ARC. Integrated multidisciplinary research at the national level is essential for proposing more intensified and sustainable farming systems. However, some experiences are ongoing in that direction. Rather than AR and development efforts being directed at the issue of productivity and how to increase it, the emphasis has now shifted towards ensuring the sustainability of production and the implications of agricultural intensification on the natural-resource base (soil and water) and the environment, in general. In cooperation with ICARDA and through financial support of the EU, ARC initiated new long-term research activities (Resource Management Program) as part of the Nile Valley and Red Sea Regional Program (NVRSRP), where multidisciplinary research teams from different institutes of ARC, DRC, NWRC, and several universities participate in planning, implementing, and following up of two main activities, namely, long-term trials and long-term monitoring on farmers' fields.

<sup>1</sup> From 1985 to 1994, NARP resources amounted to US\$ 270 million, of which US\$ 205 million were provided by the USA and US\$ 65 million by Egypt. Only about half of these resources were really going to research activities; the average external contribution to AR was US\$ 13 million or LE 45 million per year (i.e., around 30% of the 1996 ARC total resources) (see Annex 1 on NARP).

<sup>2</sup> For DRC, OCC per pRY is LE 54,100 (US\$ 15,900), for NIOF LE 12,400 (US\$ 3,600), for NRC LE 4,400 (US\$ 1,290), and for FASs about LE 600 (US\$ 180) (based on AR expenditures).



## 4.2 National and International Linkages<sup>1</sup>

### Linkages between the NARS Institutions

Linkages, until recently, were limited. It is true that FAS staff is sufficient and there is no absolute need for external expertise, and this argument is valid also for most of the ARIs, as there are abundant research scientists and so no obvious need for joining forces. However, the joint participation of FAS and ARI scientists is always helpful, as benefit from complementary expertise is maximized through synergism.

Some success stories of linkages have been developed in the past<sup>2</sup>, and for a few years now, they have been increasing in number, improving in quality, and becoming more equitable, particularly through the regional agricultural research and extension councils and the commodity campaigns (see below).

### Relations with Development

These relations have been rather weak for a long time and were hampered by many factors, such as the lack of extension policy, the lack of coordination inside MALR directorates and between ministries concerned, overstaffing and low qualified staff (especially at the middle level) and poor physical facilities in the extension services, lack of adequate attention to farmers' commercial needs, etc. (Rivera and Elkalla, 1997). However, relations with development have been largely improved during the last six years as a result of establishing the national campaigns for commodities and forming the regional research and extension councils.

National campaigns for commodities: Among the main activities of the Food, Agriculture and Irrigation Research Council of the ASRT are the national campaigns to improve production of cereals (maize, rice and wheat), oil crops, sugar crops, citrus and banana, which were launched in the early 1980s and expanded in 1994. In these campaigns, experts and scientists from research centers, universities and implementing agencies work together in order to guide producers to the use of technology packages developed by researchers<sup>3</sup>.

Regional research and extension councils: In order to promote direct and indirect interaction, coordination and cooperation between scientists, researchers, extensionists, technologists, decision-makers and farmers on a regional basis, four regional research and extension councils<sup>4</sup> were established in 1992 in four different targeted agroecological zones in Egypt: the Delta, the West Delta and the Northern Coast, the East Delta and Sinai, and Middle and Upper Egypt. The major objectives of these councils are to identify zonal constraints, support research programs and provide technological packages together with extension. The councils are responsible for:

- Discussing problems of agricultural production in the zone and suggesting solutions;
- Discussing and approving research and extension programs in the zone;
- Suggesting methods for funding and supporting research and extension programs in the zone;
- Coordinating and integrating between research programs in the different research institutions;

<sup>1</sup> Most of this section relies on Hamdi and Sabbah (FAO, 1996).

<sup>2</sup> Some examples of success stories developed by FA Alexandria: (i) The Farmers' Association established in 1983, with activities carried out in cooperation with NRC and ARC staff; (ii) A Laboratory for Animal Nutrition established jointly with NRC in 1980, which originated the National Program for Animal Nutrition since 1984, with continuous cooperation between some FAs (Alexandria, Mansoura, Ain Shams) and NRC; (iii) The Balba Group for Soil and Water Research, a scientific society formed in 1981 with the support of ASRT for strengthening scientific relations among the scientists concerned from universities and ARIs, arranging symposia, lectures, coordinating research activities among its members, publishing various periodicals and newsletters (*Alexandria Science Exchange, Advances in Soil and Water Research in Alexandria, Sahara Review, Alexogram*).

<sup>3</sup> For example, the National Campaign for Rice involves officials, experts and scientists from various sectors: MALR; ARC; ASRT; and FAs of the universities of Cairo, Alexandria, Tanta, Zagazig and Mansoura; Credit Bank; Ministry of Public Works and Water Resources; and the Society for Rice Producers. Of this group of 112 cooperators, 18 were from the universities.

<sup>4</sup> Each of the councils includes as members the deputy directors of the ARC, deans of the faculties of agriculture and veterinary medicine in the region, director of CAEE, representatives of other research institutions (DRC, NIOF, etc.) and ASRT, directors of the regional research stations, heads of the agriculture sector in the region, three directors of specialized agricultural research stations (crops, horticulture and animal production), chairman of the board of the Principal Bank for Development and Agricultural Credit (PBDAC) in the major governorate in the region, agricultural extension directors in the regional governorates, the seed director in the principal governorate, the under secretary of the Ministry of Irrigation for the region, and farmers and representatives of agricultural industries in the region.

- Monitoring and evaluating the achievements in research and extension programs in the zone.

The councils focus on specific local problem-solving activities related to the socioeconomic context of a region. Rural family development activities are also overseen by the regional councils.

**Impact on production:** Impact of AR on production is difficult to estimate as progress in production results also from many other factors and from the agricultural reform policies. What is sure is that without the AR support and results, the large increases in the yields of major crops (wheat, maize, rice, etc.<sup>1</sup>) observed during the last 10 years would not have taken place, and perspectives on the national food balance would not have changed so dramatically: according to the 1994 statistics, the food gap for grain by the year 2000 was estimated at 4.5 million tons, against 26 million tons according to 1982 statistics, recording a reduction of about 83%.

### International Scientific Cooperation

As seen above, most of the NARS institutions have developed rather strong collaboration with a large number of external scientific institutions, among them are the international AR centers (IRRI, ICARDA, CIMMYT, CIP, IPGRI, IIMI, IFPRI, ICRISAT and ICLARM), US universities, and European AR institutes. These relations have been supporting research and training activities funded most often by donors (see Section 3.3).

## 5. CONCLUSION

The Egyptian NARS has numerous strengths. Its structure is globally satisfactory: the NARS is relatively not much fragmented, with a relatively few number of well-established and experienced main institutions, and a unique body responsible for the overall AR policy (the National AR Council). It has a high number of well-trained scientists and technical support staff, rather good infrastructure and research facilities, and benefits from the full confidence of the national authorities and has strong international scientific and financial support.

However, the NARS is facing some major weaknesses and constraints. Its high scientific potential is actually rather poorly mobilized due to the limited financial capacity of the country, the weight of salary costs and the low operation and capital budgets available. As almost all the agricultural administration<sup>2</sup>, the NARS is certainly overstuffed, as a direct result of the Government's previous guaranteed employment policies for university and secondary school graduates. With the same financial resources, a more equilibrated allocation with lower salary expenditures and improved operation/capital budgets would allow to increase the efficiency of the staff and the NARS.

Even if there is considerable documented evidence of increasing and successful collaboration, linkages within the Egyptian NARS, especially between the ARIs and the FASs, remain limited compared to total activity in the agricultural research and education sector.

Relations with development are improving; however, the relatively weak permanent presence in the Upper and Middle Nile Valley (which results from the excessive concentration of scientific potential in Cairo and the Delta) is a very limiting factor for more efficient cooperation.

The NARS is moving and will certainly be able to take advantage of opportunities for greater efficiency, sustainability and impact.

### Main Acronyms

**ME:** Ministry of Education. **MALR:** Ministry of Agriculture and Land Reclamation, formerly Ministry of Agriculture. **MSRT:** Ministry of Scientific Research and Technology. **MPWWR:** Ministry of Public Works and Water Resources.

**ARC:** Agricultural Research Center. **ASRT:** Academy of Scientific Research and Technology. **DRC:** Desert Research Center. **ENAL:** Egyptian National Agricultural Library. **FAS:** Faculty of Agricultural Sciences. **FA:** Faculty of Agriculture. **FVM:** Faculty of Veterinary Medicine. **NARC:** National Agricultural Research Council. **NARP:** National Agricultural Research Project. **NIOF:** National Institute of Oceanography and Fisheries. **NRC:** National Research Center. **NWRC:** National Water Research Center.

<sup>1</sup> The national yields for wheat, maize and rice have increased from 3.20, 4.13 and 5.70 t/ha in 1982 to 6.07, 7.88 and 8.33 t/ha, respectively, in 1995.

<sup>2</sup> Which employs close to half a million people, almost 12% of the formal agricultural labor force as well as 12% of total Government employees (Rivera and Elkalla, 1997).

**LE:** Egyptian Pound.

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**Annex 1 - Some Information on the National Agricultural Research Project (NARP)**  
(MALR/ARC/NARP, 1995)

NARP was implemented by the Egyptian Government with the support of USAID from 1985 to 1995. Its main objectives were human resource development, capacity building, interdisciplinary and collaborative research through local and international linkages, generating improved and new agricultural technology through research, initiating institutional reforms, and building more effective links between research and extension entities and farmers for diffusion of new technologies and feedback from farmers to research on their needs and constraints.

- NARP resources: USA: US\$ 205 million, Egypt: LE 219 million (around US\$ 65 million).

- US grant components: Research: 64%, technology transfer: 11%, seed technology: 8%, policy analysis: 3%, "new initiatives" (mullet fish, crop biotechnology, rinderpest, anaplasmosis, soybean, poultry, whitefly, machinery, and agroforestry): 12%, economic studies on new lands development, commodity marketing systems): 1%.

- Research components:

- Research support program for the ARC: US\$ 12m (10 for operation): 284 grants, more than 3,000 researchers;
- Research grants for universities and non-ARC research institutes: US\$ 9m (3 for operation): 201 grants, more than 1,800 scientists; including: US\$ 7.7m (5 for operation) and 175 grants for universities;
- Collaborative research program for joint research programs with US research institutions and universities: US\$ 20m, more than 300 scientists;

Other items: US\$ 58m (ENAL: US\$ 6m; Renovation of AR facilities: 29 sites in 19 research stations: US\$ 7m; ARC labs, offices, research stations: US\$ 25m; ARC land improvement in 13 research stations: US\$ 13m; on-farm trials (field and horticultural crops): US\$ 1m; IRRI joint program: US\$ 4m, ICARDA/CIMMYT joint program: US\$ 2m).

Table 1 - The National Agricultural Research System (1996/97)

Rounded numbers (see Tables 2, 3, 4). <i>Italic's</i> Approximate data. -- Data not available. % See footnotes. NARS Institutions				AR Scientific & Technical Graduate Staff (Units)			Potential Res. Years		Total Budget (1000 LE)		AR Expenditures/Resources(£) (1000 LE)		
No	Name - Acronym Head Office - Year Established	Mandates AR Fields	Govern. Ministry	Nationals Total (Ph.D., MS)		Exp.	Nat.	Exp.	Nat.	Ext.	Nat. NE	For. FE	Total TE
a	b	c	d	e	f	g	h	i	j	k	l	m	n
11	Agricultural Research Center 24 res. units ARC Cairo (see Table 2)	AR (33%) - (AD) All ext. fish.	MALR	5620	2700, 1400		3140		232,000*	28,900*	124,500	18,200	142,700
21	Desert Research Center Cairo	DRC 1939, 90	AR (70%) - (AD) All ext. fish.	MALR	380	340, 80	230		23,000	600	20,000	700	20,700
22	Nat. Inst. of Oceanography & Fisheries Alexandria	NIOF 1927, 1986	AR (100%) Oceano., aquac.	MSRT	480	340, 130	430		12,000	2,900	12,000	2,000	14,000
1-3	Total AR Institutes			6380	3620, 1610	0	3800	0	267,000	28,900	156,500	20,900	177,400
31	18 Faculties of Agriculture Cairo, Alexandria, etc. (see Table 3)	FA 1935-96	AHE - (AR) All	ME	4640	3260, 540	1160		111,000	4,500	11,100	450	11,550
32	8 Faculties of Veterinary Medicine Cairo, Alexandria, etc. (see Table 3)	FVM 1935-90	AHE - (AR) An. prod/health	ME	1260	810, 210	320		32,000	600	3,200	50	3,250
3	Total Faculties of Agricultural Sciences			5900	4070, 750	0	1480	0	143,000	5,100	14,300	500	14,800
41	National Research Center * Cairo (see Table 4)	NRC 1956	R - (AR) Diverse	MSRT	1180	700, 280	950		29,000	1,500	28,800	1,300	27,100
42	National Water Research Center * Cairo (see Table 4)	NWRC 1975, 1994	R - (AR) Irrigation	MPWWR	130	30, 40	100		3,500	600	2,900	600	3,500
43	Atomic Energy Authority * Cairo (see Table 4)	AEA 1955	R - (AR) Diverse	MEE	330	340, 80	280		6,900	-	6,900	-	6,900
44	Fac. of Engin., Sciences, Econ., etc. (see Section 2.4)	E - (AR div.)	ME	300	280, 60	100		-	-	800	-	-	800
4	Total Other Scientific Institutions			2040	1150, 460	0	1430	0	39,400	2,100	35,600	1,900	37,700
5	Total NARS			14320	8240, 2820	0	6710	0	455,300	38,000	206,600	23,300	229,900
Exchange Rate: US\$ 1 = LE 3.4 (Average rate for 1997)				Actual Research Years (a.R.Y.s) (Estimated) →			1000 - 1000	0	AR Expenditures (in million US\$) →		60.8	6.8	67.6

ME: Ministry of Educ. MEE: Min. of Electricity & Energy MALR: Min. of Agric. & Land Reclamation MSRT: Min. of Scient. Res. & Technology MPWWR: Min. of Public Works and Water Resources

c. Mandates AR ( % ) Approximate average % of graduate staff's time devoted to ag. research (AR), R: Research, AHE: Ag. higher education, AD: Ag. development enterprises (for AR and AHE institutes seed production, and analysis, extension, etc.). J: potential research year (p.R.Y.) = equivalent full-time researcher, for the FAAs, p.R.Y.s were estimated by multiplying the number of academic staff by 25%

\*Notes 1: Total budget only of the 24 research units of ARC 4.1, 4.2, 4.3 data related only to the units of these institutions which are mainly involved in AR

National AR expenditures (NE) 0.50% of the Agricultural Gross Domestic Product (AGDP: US\$ 12.1 billion in 1996) Total AR expenditures (TE) 0.56% of the AGDP

Table 2 - The Agricultural Research Center (ARC): Its Institutes and Central Laboratories (1996/97)

ARC Research Institutes (RI) and Central Laboratories (CL)					Graduate Scient. & Tech. Staff (Units)		Potent RYs*	Total Budget (1000 LE)		AR Expenditures/Resources (E) (1000 LE) *		
No	Name – Acronym Year Established - Mandates (% of resources devoted to AR) *				Nationals Total - (PhD , MS)		Nat.	Nat.	Ext.	Nat. NE	For. FE	Total TE
1	Soil, Water and Environment RI	SWERI	1903, 71	50%	610	369 , 183	305	20,900	2,500	15,700	1,900	17,600
2	Field Crops RI	FCRI	1903, 73	75%	581	282 , 82	436	9,800	1,000	8,600	900	9,500
3	Horticulture RI	HRI	1911, 71	50%	748	239 , 183	374	18,000		13,500		13,500
4	Sugar Crops RI	SCRI	1913, 83	50%	156	49 , 41	78	3,500	700	2,600	500	3,100
5	Cotton RI	CRI	1920, 71	75%	184	140 , 19	138	4,500		3,900		3,900
6	Agric. Genetic Engineering RI	AGERI	1989	80%	74	17 , 29	59	1,000	4,000	900	3,600	4,500
7	Plant Pathology RI	PPATHRI	1919, 73	75%	371	191 , 100	278	6,300	3,000	5,600	2,600	8,200
8	Plant Protection RI	PPRI	1889, 83	50%	542	323 , 151	271	10,200		7,600		7,600
9	Animal Production RI	APRI	1908, 71	60%	296	202 , 66	178	21,000	3,400	16,800	2,700	19,500
10	Animal Reproduction RI *	ARRI	1968, 83	60%	152	56 , 28	91	3,200	€	2,600	€	2,600
11	Animal Health RI	AHRI	1904, 83	40%	360	274 , 72	144	9,100		6,400		6,400
12	Veterinary Serum & Vaccine RI	VSVRI	1903, 83	40%	298	96 , 59	119	5,300	4,900	3,700	3,400	7,100
13	Agricultural Engineering RI	AENRI	1983	50%	97	27 , 58	49	3,200	900	2,400	700	3,100
14	Food Technology RI	FTRI	1991	60%	283	116 , 48	170	5,800		4,600		4,600
15	Agricultural Economics RI	AERI	1943, 71	60%	192	115 , 58	115	4,500	300	3,600	200	3,800
16	Agr. Extension & Rural Devel. RI	AERDRI	1943, 77	60%	185	64 , 73	111	2,100		1,700		1,700
17	CL for Agricultural Climate	CLAC	1996	40%	94	11 , 32	38	1,100	500	700	300	1,000
18	CL for Date Palm Res.	CDPR	1996	100	13	4 , 3	13	500		500		500
19	CL Agricultural Pesticides Lab	CAPL	1963, 83	50%	169	59 , 25	85	4,100	1,000	3,100	800	3,900
20	Lab of Residue Analysis of Pestic.	LRAP	1995	20%	22	4 , 7	4	900	600	500	400	900
21	CL for Aquaculture Res.	CLAR	1987, 91	40%	69	22 , 38	28	500		300		300
22	CL for Food and Feed	CLFF	1980, 85	25%	44	16 , 17	11	3,100		1,900		1,900
23	CL for Design & Stat. Anal. Res.	CLDSAR	1940, 71	60%	60	16 , 22	36	800		600		600
24	CL Lab for Agric. Expert Systems	CLAES	1989, 91	40%	17	5 , 5	7	700	400	500	200	700
A	Total Institutes & Central Labs				5617	2697 , 1399	3138	140,100	23,200	108,300	18,200	126,500
B	ARC General Administration				–	... , ...		92,100	–	16,200*	–	16,200
C	Total ARC				5617	2697 , 1399	3138	232,200	23,200	124,500	18,200	142,700

\*: Notes:

- Mandates: Average % of time devoted by the graduate staff members (gsm) to AR.

- PRYs = potential research years = number of gsm × average % of time devoted by the gsm to AR.

- Total budget and AR expenditures: rounded numbers. For the RI number 10, external grants: € – LE 30,000.

- In general, AR activities are more expensive than the other activities conducted by the research units (development, extension, training), thus, the AR expenditures have been roughly estimated from the following formula: Total budget × [% resources devoted to AR + 0.5(100% - % resources devoted to AR)]/100.

- In row B, the amount LE 16,200 million represents 15% of the AR national financial resources of the ARC research units, considered as a rough estimate of the general administration/management costs devoted to the concerned units by the ARC Directorate.

**Table 3 - Faculties of Agriculture (FA) and Veterinary Medicine (FVM) (1996/97)**

Faculties				Graduate Acad. Staff Members (Units)		Potent RYs *	Total Budget (1000 LE) *		AR Expendit./Res (E) (1000 LE) *		
	Name Location - Year Established	Mandates	Nationals Total - (PhD , MS)	Nat.	Nat.	Ext.	Nat. NE	For. FE	Total TE		
1	FA-Cairo Un./Giza 1935	All	868	538 , 75		10,800	600				
2	FA-Cairo Un./Fayoum 1976	All exc. fish	203	118 , 42		3,900	250				
3	FA-Ain Shams Un./Cairo 1950	All	499	371 , 60		16,800	900				
4	FA-Alexandria Un./Alex., El-Shatby 1942	All	498	392 , 63		19,000	800				
5	FA-Alexandria Un./Alex., Sabba Pasha 1959*,75	All	84	66 , 9		1,600	100				
6	FA-Alexandria Un./Damanshour 1987,91	All exc. fish	34	21 , 3		600	50				
7	FA-AI Azhar Un./Cairo 1963	All	322	239 , 42		4,700					
8	FA-Suez Canal Un./Ismailia 1976	All	169	114 , 37		2,800	400				
9	FA-Suez Canal Un./El-Arish 1990	Agr, environ	31	22 , 8		2,000					
10	FA-Zagazig Un./Zagazig 1957,69	All exc. fish	475	230 , 22		12,500	450				
11	FA-Zagazig Un./Moshtohor 1957,74	All	185	141 , 28		4,400	100				
12	FA-Assiut Un./Assiut 1959	All exc. fish	298	213 , 50		5,200	200				
13	FA-Mansoura Un./Mansoura 1957,69	All exc. fish	217	186 , 23		3,800	150				
14	FA-Minia Un./Minia 1957,69	All exc. fish	221	178 , 37		4,700	100				
15	FA-Menoufia Un./Shebin El-Kom 1957,69	All exc. fish	235	206 , 18		10,200	100				
16	FA-Tanta Un./Kafr El-Sheikh 1957,69	All exc. fish	240	186 , 22		6,400	200				
17	FA-Tanta Un./Tanta 1993	All exc. fish	45	29 , 3		1,000	100				
18	FA-South Valley Un./Sohag 1996	All exc. fish	19	6 , 1		800					
A	<b>Total 18 Faculties of Agriculture (FA)</b>		<b>4643</b>	<b>3256 , 543</b>	<b>1160</b>	<b>111,200</b>	<b>4,500</b>	<b>11,100</b>	<b>450</b>	<b>11,550</b>	
19	FVM-Cairo Un./Cairo 1935	Liv.	334	264 , 26		14,600	200				
20	FVM-Cairo Un./Beni Suef 1982	Liv., fish.	83	51 , 10		1,550					
21	FVM-Alexandria Un./Alex. 1975	Liv.	100	75 , 18		2,400	150				
22	FVM-Suez Canal Un./Ismailia 1986	Liv.	154	38 , 50		3,100	100				
23	FVM-Assiut Un./Assiut 1961	Liv.	123	100 , 15		3,400	100				
24	FVM-Zagazig Un./Zagazig 1969	Liv., fish.	257	175 , 32		4,300	70				
25	FVM-Zagazig Un./Banha 1982	Liv.	111	72 , 24		1,250	20				
26	FVM-Tanta Un./Kafr El-Sheikh 1990	Liv.	89	31 , 32		1,000					
B	<b>Total 8 Faculties of Veterinary Medicine (FVM)</b>		<b>1251</b>	<b>806 , 207</b>	<b>313</b>	<b>31,600</b>	<b>640</b>	<b>3,200</b>	<b>50</b>	<b>3,250</b>	
C	<b>Total Faculties of Agriculture and of Veterinary Medicine</b>		<b>5894</b>	<b>4062 , 750</b>	<b>1473</b>	<b>142,800</b>	<b>5,140</b>	<b>14,300</b>	<b>500</b>	<b>14,800</b>	

\*: Notes:

- PRYs = potential research years = number of graduate academic staff members × 25% (= normative average % of time potentially devoted to AR).
- Total budget and AR expenditures: rounded numbers.
- AR expenditures: estimated roughly as 10% of the total expenditures (see Section 2.3).



Table 4 - The Other Institutions of the NARS (1997): AR in NCR, NWRC and AEA

NARS Institutions			AR Scientific & Technical Senior Staff (Units)		Potential Res. Years		Total Budget (1000 LE)		AR Expenditures/Resources (E) (1000 LE)			
No.	Name - Acronym (Head Office - Year Established)	Mandates AR Fields	Nationals Total - (PhD, MS)	Exp.	Nat.	Exp.	Nat.	Ext.	Nat. NE	Loan LE	For. FE	Total TE
1	b	c	f	g	m	i	j	k	l	n	p	p
1	National Research Center/Cairo	NRC-1956	R - (AR: all) - (AD)									
	a. Agr. and Biological Res. Division	1968	AR 90%	580	420, 130		520	15,000		14,300		
	b. Food Industry Res. Division	1968	AR 90%	300	110, 50		270	3,000	1,500	2,500		
	c. Basic Sciences Res. Division	1977	AR 50%	200	120, 60		100	4,000		3,600		
	d. Genetic Engin. & Biotech. Res. Division	1986	AR 60%	100	50, 40		60	5,000		4,600		
	Total AR Units in the National Research Center		1180	700, 280		950	0	29,000*	1,500	25,800*	1,300	27,100
2	National Water Res. Center/Cairo	NWRC-75	R - (AR) - (AD)									
	a. Water Management Res. Inst.	WMRI-1975	AR 50% (land, water)	60	20, 15		30	2,300		1,700		1,700
	b. Drainage Res. Inst.	DRI-1976	AR 100% (land, water)	70	10, 25		70	1,200	600	1,200	600	1,800
	Total AR Units in the National Water Research Center		130	30, 40	0	100	0	3,500	600	2,900	600	3,500
3	Atomic Energy Authority/Cairo AR total	AEA-1955	R - (AR) - (AD)									
	a. Nuclear Research Center	NRC-1955										
	- Biological Applications Dept.	1965	AR 85% (zool, entomol.)	110	45, 30		94	1,500		1,800		1,800
	- Soil and Water Dept.	1974	AR 80% (soil, water)	35	20, 5		28	800		700		700
	- Isotopes Lab.	1975	AR 80% (chem, biotech.)	35	35, 25		50	7,000		1,000		1,000
	b. Nation. Center for Radiation Res. & NCRRT-72											
	- Radiation Microbiology Dept.	1972	AR 80% (microbiol.)	50	20, 10		42	900		800		800
	- Natural Products Dept.	1995	AR 90% (genetics, physics)	50	20, 10		48	1,300		1,200		1,200
	Total AR Units in the Atomic Energy Authority		330	140, 80	0	280	0	6,900		6,300		6,300
4	Total 1 + 2 + 3		1640	870, 400	0	1330	0	39,400	2,100	35,600	1,900	36,900

\* NCR: An amount of LE 2 million from national sources (e.g., ASRT) is shared among the divisions; this has been multiplied by an average calculated from the % resources devoted to AR of the four divisions and added to the national component of AR expenditures.

Note: For a better appraisal of the AR financial resources of these three institutions, it is necessary to take into account the administration/ management costs devoted to the concerned units at the level of the directorates of these institutions; accordingly, Table 1 reports the above national AR financial resources with a 15% increase

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF ERITREA<sup>1</sup>

## 1. HISTORICAL BACKGROUND

The history of agricultural research (AR) in Eritrea can be divided into five periods: the Italian (colonial), British, post-British, Ethiopian and the Eritrean People's Liberation Front (EPLF) (MOA, 1995).

The Italian colonial government established research farms in 1910 at Filfil and Fagena in the eastern slopes and at Keren and Adi Ugri. Introductions of coffee (from Yemen) and several plant species were made. Research in the western lowlands started in the early 1920s with the creation of a research farm constructed at Tessenei (essentially for cotton).

Little information is available on AR in Eritrea during the British period. It is known, however, that the Tessenei cotton farm was taken over by the British in 1939 and mainly sorghum was grown.

When the British left, the Italians took over the Tessenei farm in 1952. Research farms at Sembel, Daro Kawlos (near Asmara) and Adi Ugri (Mendefera) were established as highland and midland sites. Cereals, mainly wheat and barley, were given high priority in the highlands. An international wheat rust nursery was established at Paradiso in the 1960s; varietal introductions and selections were made from Kenya and from CIMMYT in Mexico.

During the Ethiopian period, the Tessenei farm was given to a semi-government enterprise in 1976, which renovated it. Cotton germplasm was introduced from the United States and Israel. Research facilities, including greenhouses, were established at Sembel and Paradiso by the Imperial Ethiopian Government, but these were abandoned because of the war in Eritrea. The original goal of the research sites was to conduct research on highland cereals. Some initiatives were also taken by the University of Asmara (UOA): its Department of Agriculture established research sites at Imbatkala (for dryland agriculture, cowpea and beans, etc.), Halhale (horticulture, cereals) and Abarda (forages), and its Department of Biology created in 1986 a unit of Arid Zone Agriculture.

During the war, EPLF implemented some AR programs (soils, horticulture, agronomy, crop protection, forestry and range management, animal science and farm machinery) in the areas it controlled. A training program was established on general agriculture, animal production, veterinary science, motor-pump maintenance and home economics for farmers and EPLF members.

After independence in 1991, the Department of Agricultural Research and Training (DART) was established in 1992, and was mandated with conducting research in the fields of crop improvement, soil, plant protection, agricultural engineering, livestock and forestry, and also with carrying out vocational training in agriculture. In 1995, DART changed its name to the Department of Agricultural Research and Extension (DARE), with its research mandate remaining the same, while extension was included as an additional mandate, and its training component transferred to another department in the Ministry of Agriculture (MOA). A change in structure took place i name was changed to the Department of Agricultural Research and Human Resource Development (DARHRD).

The UOA Unit of Arid Zone Agriculture became the College of Agriculture and Aquatic Sciences (CAAS) in 1992. The Research and Training Division (RTD) of the Ministry of Marine Resources was created in 1993.

## 2. THE CURRENT NARS

### 2.1 Overview

Currently, the Eritrean public NARS consists of three institutions:

- Two institutions mainly specialized in AR: DARHRD of the Ministry of Agriculture (MOA), covering all fields except fisheries, and the Research and Training Division (RTD) of the Ministry of Marine Resources (MMR), for marine research: they account together for 77% of the total potential research years (pRYs: equivalent full-time researchers) and 78% of the total financial resources of all the NARS; these two institutions are presented in Sections 2.2 and 2.3.
- The UOA College of Agriculture and Aquatic Sciences (CAAS), presented in Section 2.4.

<sup>1</sup> By Mr Tekleab Mesghena, Director General, Department of the Environment, Ministry of Land, Water and Environment, and Dr Bissrat Ghebru, Assistant Professor, College of Agriculture and Aquatic Sciences, University of Asmara.

These institutions are not coordinated at any central level, but have rather good relations (see Section 4.2).

Outside the public NARS, AR is carried out by a few private non-profit NGOs, among which World Vision Eritrea<sup>1</sup> is probably the only active one in collaboration with DARHRD.

## **2.2 The Department of Agricultural Research and Human Resource Development (DARHRD)**

**Mandate and Organization** - DARHRD is an administrative Division of MOA which reports directly to the Vice Minister of Agriculture. It has four sections: agronomy and forestry (supported by two labs: gene bank, plant protection), soil science, animal science, and agricultural engineering. AR activities are essentially applied and adaptive; they mobilize around 70% of the time of the senior staff, the remaining time is devoted to services, extension/development (soil analysis, seed production, on-farm trials, technology information, etc.), and in-service training activities (for MOA staff and farmers).

**Resources** - The current available permanent staff is about 71, of whom there are 39 researchers (37 nationals: 10 MS and 27 BS holders; 2 expatriates), 26 technicians, and 6 clerks. There are also 50/200 daily laborers, depending on the season (planting, weeding and harvesting periods require many laborers).

In spite of recruiting an additional number of staff during the last years (in 1995 there were only 16 national researchers: 5 MS and 11 BS), the shortage of qualified personnel is the limiting factor in DARHRD, which limits its capacity to properly plan and implement AR activities<sup>2</sup>. Considerable efforts are being made to improve human resource capabilities through short- and long-term training programs. The government has introduced a new salary scale (ranging roughly between US\$ 160 and 500 for technicians and senior researchers, respectively) which is believed to be attractive, considering the current economic situation of the country.

DARHRD has established three main research stations, each representing different agroecological zones and production systems. Halhale Research Station (300 ha) in the central highlands zone hosts DARHRD headquarters which moved recently from Paradiso/Asmara; it enjoys new infrastructure (building complex, including offices and laboratories) and fair transportation and communication facilities. Shambuko Research Station (300 ha for research and seed multiplication purposes) in the southwestern lowland zone has also fair infrastructure (well-established office and living quarters for research staff) and transportation/communication facilities. Sheib Research Station (50 ha for research and seed multiplication) in the eastern lowlands (coastal plain zone) is a new station where new offices and housing for researchers are being constructed.

In 1997, total DARHRD financial resources amounted to Birr 9.8 million (US\$ 1.6 million), of which:

- Birr 2.3 million (US\$ 0.4 million) came from national sources (essentially from the government budget, plus some self-earned sources coming mainly from seed sales), with 34% allocated to salaries and wages and the remaining (Birr 1.5 million) to operating/capital costs (OCC); and
- Birr 7.5 million (US\$ 1.2 million) from external grants (DANIDA, FAO/Italian Cooperation, and USAID), covering the cost of the two expatriates, staff training, and contribution to the OCC.

The total OCC amounted roughly to Birr 56 million, which means around US\$ 30,000/36,000 per pRY, a largely sufficient amount for providing good research means.

**Research Activities and Linkages** - In the research planning process, frequent consultations with division heads in the department and individual researchers (which in a way forms an informal technical scientific committee) helps the director to set policies and approve programs and budgets. Steps are being taken to institutionalize the planning and management of research activities.

## **2.3 The Research and Training Division (RTD) of the Ministry of Marine Resources (MMR)**

**Mandate and Organization** - RTD is now in its earliest stage of development and in the process of building its human resources through training and its research infrastructural capacities. Its mandate equally covers marine research (focussed on marine habitat and fisheries) and training/extension (short-term training of fishermen on navigation, making of fishing nets, and training women on nutrition at its training center located in Hirigogo).

<sup>1</sup> It started adaptive trials in 1996 of some crops (finger millet, groundnut, pigeon pea) in the southern part of Eritrea, aimed to identify and select drought-tolerant, disease-resistant, high-yielding cultivars adapted to the region. The adaptive trials will soon cover additional crops (sorghum, maize, sesame, bean, etc.).

<sup>2</sup> According to the medium-term plan (MOA, 1995), the required number of researchers and technicians for DARHRD for the year 2002 is 109 (14 PhD, 38 MS, 57 BS) and 128, respectively.

**Resources** - RTD has a total of 60 permanent staff members, including 36 national senior members (all with BS degree) and four foreign scientists, who represent 20 pRys. The remaining are support staff, including technicians and workers.

Physical resources are currently meager. The main office is in Massawa and a branch office in Assab, but there is no infrastructure for research, no appropriate station equipped with laboratories, and no research vessel. RTD plans to have additional stations in Dahlak, Tio and Brassole islands.

Funds provided in 1997 by MMR were scarce and amounted to (rough estimate) around Birr 250,000 (around US\$ 40,300), or US\$ 1,000 per professional staff member, all expenses included. There is, however, a number of research funds available from international organizations for joint research programs (roughly estimated at US\$ 0.5 million, including the cost of the four expatriates). The available operation/capital funds, provided by the foreign assistance, may cover the needs of around 10 actual RYs.

**Research Activities** - Research activities focus on marine habitat and fisheries, and the main activities are baseline data collection on various aspects of the marine environment, surveys of fish stocks (with fishermen), and the creation of environmental awareness for sustainability.

## **2.4 The College of Agriculture and Aquatic Sciences (CAAS) of the University of Asmara (UOA)**

**Overview** - CAAS is the only source of trained personnel in agriculture in the country. It offers four-year BS programs in plant science/crop production, soil and water conservation, animal sciences, marine biology and fisheries, and soon in agricultural economics. A two-year diploma in general agriculture will be added over the next years.

CAAS has currently 36 academic full-time staff members, including 32 nationals (3 PhD, 15 MS and 14 BS holders) and 4 expatriates. As part of the UOA, which is currently in an aggressive staff-development stage, it is building its human resource capacity steadily but surely. In 1994, it had 19 academic full-time staff members (3 PhD, 10 MS and 6 BS holders), and for the past two years it has trained or is still in the process of training 7 staff members at the PhD level and 9 at the MS level. It is also recruiting senior staff periodically to fill its requirements.

CAAS occupies a building that will soon be refurbished to accommodate four laboratories and a number of lecture halls and staff offices. A college farm and an experimental field exist on the campus. Currently, physical facilities are not optimal for undertaking major research activities, but CAAS also shares the experimental fields of MOA when needed for research.

In 1997, CAAS financial resources amounted to Birr 12.6 million (US\$ 2 million) of which about 10% were funded by the Government and 90% by foreign donors, mostly spent on staff training, equipment and salary of seconded staff.

**Research Activities** - In addition to being an academic institution, CAAS is mandated to conduct basic and applied research that addresses developmental needs and to disseminate research results through outreach programs. CAAS staff members allocate about 25% of their time at the moment for research in agriculture and marine sciences; this would increase with the availability of research facilities. Research priorities are identified on the basis of its sectorial surveys (CAAS et al., 1996) and in accordance with the national agricultural development policy.

## **3. AR RESOURCES**

NARS in Eritrea has not yet developed a well-structured management and monitoring system for human, material and financial resources. For example, methods and procedures have not been developed strongly for evaluating staff performance capacity, and the management of financial resources is not properly organized, although measures are now being taken by NARS institutions to strengthen their management of available resources.

### **3.1 Human Resources**

Currently (1997) the public Eritrean NARS involves 115 scientific and technical senior graduate staff (including 10 expatriates), who represent around 61 potential RYs. Among the 105 national senior staff, only 3 have a PhD degree, 25 an MS, and 77 a BS. The level of academic training is particularly poor at DARHRD and RTD.

More trained staff, both in number and quality, is needed. For the short-term period, the Government is trying to overcome the shortcomings by contracting foreign nationals, and more importantly, through south-south cooperation. The provision of technical assistance attached to donor projects is another source for meeting some of the critical demands on qualified personnel. For the long-term period, the enhancement of CAAS and the enlargement of its

education mandate should allow intensive undergraduate/postgraduate training courses and also training of technicians, for which increased recruitment of additional staff is strongly required.

### **3.2 Physical and Financial Resources**

The current infrastructure of NARS to carry out effective research plans is very limited. However very important efforts have been made and will be undertaken for the next years to enlarge it in every NARS institutions.

In 1997, the national AR financial resources amounted to around Birr 2.5 million (US\$ 0.4 million), mainly from the government budget, which represent 0.33% of the Agricultural Gross Domestic Product (AGDP estimated at US\$ 120 million in 1996). National/government investment in AR is far from the 1% of the AGDP recommended by some international organizations. However, the figures over the past two or three years indicate signs of good progress. For example, the contribution to AR from the MOA budget was about 0.24% in 1993/94, but has increased to 2.1% in 1997.

AR financial resources from external grants amounted to around Birr 11.4 million (US\$ 1.8 million), which are equivalent to around US\$ 1.4 million (1.2% of the AGDP) when estimated at the "national cost" (evaluating the cost of the expatriates on the basis of the average annual cost of the national scientists). This external support provides the NARS institutions with scientific support and with operational/capital funds necessary for providing satisfactory means for research, except in the case of RTD; and the actual RYs of the NARS should amount to around 50, as opposed to the 61 pRYs.

Total AR fina  
thus US\$ 1.8 million (national = US\$ 0.4 million; external: US\$ 1.4 million).

## **4. RESEARCH ACTIVITIES**

### **4.1 Research Activities and Orientations**

AR activities are at an early stage of development, and resources allocated to the programs implemented are constantly moving and increasing. Thus, it is too soon to present a balance on the past and current activities.

Research orientation has been defined by the Government of Eritrea (GOE, 1994) through its medium-term plan (MTP) and strategy (1997/2002), prepared in cooperation with the NARS institutions. As rainfall is the most limiting factor to food production, emphasis is on developing irrigated agriculture by enhancing the productivity of farmers, pastoralists and agro-pastoralists. AR has been prioritized at two levels: commodity and production system. It will emphasize the production of high-value crops and the development of irrigation water resources to support an export-oriented agricultural sector. Improvements in the production levels of national food crops and livestock will also receive enough attention to achieve some level of self-sufficiency. Station-based applied and adaptive research on existing and imported technologies, and on-farm trials and production system improvement activities will be conducted. This will be carried out by research extension teams; concentrating on farmer participation to adjust research plans and operations.

### **4.2 National and International Linkages**

So far, the limited human and physical resources of the NARS have been limiting its relations with development/extension organizations. The setting up of farming systems research programs scheduled in the medium term should help AR to better contribute to development by identifying production constraints, developing appropriate technologies, and introducing viable alternatives to farmers.

Linkages between the NARS institutions are relatively pronounced. DARHRD and CAAS have strong working relationships that have developed over a relatively short period of time. For example, a joint steering committee drawn from both institutes was established to guide in planning CAAS curricula relevant to the objectives of the country; and a task force representing DARHRD and CAAS was formed to guide in the preparatory process of the MTP and strategy for national agricultural research. MOA and UOA enjoy good bilateral cooperation with various donors in research and training. RTD and the Marine Biology and Fisheries Department of CAAS have a joint steering committee aimed at sharing expertise and information and at combining efforts in marine research; however, this committee has not yet succeeded in bringing changes since both institutes are still in the development process.

International scientific linkages are rather well developed. International research centers and networks are major sources of germplasm, training and technical expertise for DARHRD, which has good working relationships with

ICARDA, ICRISAT, ILRI, CIP and CIMMYT. At the regional level, DARHRD and CAAS collaborate with the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA), which aims at promoting collaboration in AR in the region. CAAS has agreements related to funding, training, exchange of expertise and research collaboration with some European scientific institutions (AS University of Agriculture in Norway; Wageningen University, Larenstein International Agricultural College of Agriculture, and Dronen Agricultural College in the Netherlands).

## 5. CONCLUSION

The Eritrean NARS is by world standards quite small, with its 61 pRYs and US\$ 1.8 million resources. However, it resulted from very recent efforts, undertaken by the country with strong scientific and financial support from the international community, to build research and education institutions able to support national agricultural development and ensure a sustained output of improved technology to farmers.

### Main Acronyms

**MOA:** Ministry of Agriculture. **MMR:** Ministry of Marine Resources.

**CAAS:** College of Agriculture and Aquatic Sciences of the University of Asmara (UOA). **DARE:** Department of Agricultural Research and Extension. **DARHRD:** Department of Agricultural Research and Human Resource Development. **RTD:** Research and Training Division of MMR.

### Main References

Government of Eritrea - *Macro-policy*.- Asmara, 1994.

MOA - *Medium-Term Plan And Strategy for National Agricultural Research*.- Asmara, June 1995,102 p.

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Table 1 - The National Agricultural Research System (1996/97)

*Italics*

NARS Institutions				AR Scientific & Technical Graduate Staff (Units)			Potential Res. Years (pRY)		Total Budget (1000 Birr)		AR Expenditures/Resources (E) (1000 Birr)		
No.	Name - Acronym Head Office - Year Established	Mandates AR Fields	Govern. Ministry	Nationals Total - (PhD, MS)		Exp.	Nat.	Exp.	Nat.	Ext.	Nat. E NE	For. E FE	Total E TE
a	b	c	d	e	f	g	h	i	j	k	l	m	n
1.1	Dept. of AR & Human Resource Developm. DARHRD Hahale	AR (70%) - (AD) All exc. fisheries	MOA	37	0, 10	2	26	1	2,300	7,500	2,000	6,400	8,400
2.1	Research and Training Division Massawa	RTD 1993	MMR	36	0, 0	4	18	2	250	3,000	200	2,200	2,400
1-2 Total Agricultural Research Institutes				73	0, 10	6	44	3	2,550	10,500	2,200	8,600	10,800
3.1	College of Agriculture & Aquatic Sciences CAAS Asmara	AHE - AR (25%) All	ME	32	3, 15	4	13	1					3,100
3 Total Faculties of Agricultural Sciences				32	3, 15	4	13	1	1,300	11,300	300	2,800	3,100
3 Total NARS				105	3, 25	10	57	1	3,850	21,800	2,500	11,400*	13,900
Exchange Rate: US\$ 1 = Birr 0.2 (1997 average official rate)				Actual Research Years (aRYs) (Estimate) →				50	AR Expenditures (million US\$) →		0.4	1.4*	1.8

MOA: Ministry of Agriculture; MMR: Ministry of Marine Resources; ME: Ministry of Education.

c: Mandates: AR (%): Approximate average % of human resources devoted to ag. research (AR); R: Research; AHE: Ag. higher education; AE: Professional education; AD: Ag. development/services (for AR and AHE institutes: seeds production, soil and water analysis, extension, studies, etc.). h, i: potential research-year (pRY) = equivalent full-time researcher; for the FASs, the pRYs have been estimated by multiplying the number of academic staff by 0.25. m: For the AR institutes, AR financial resources have been roughly estimated through the following formula: Total budget × [(h + 0.5(100% - h)) where h is the % of time devoted to AR by the graduate staff.

\* Note: The total AR expenditures of the NARS from external grants (Birr 11.4 million or US\$ 1.8 million) are equivalent to around US\$ 1.4 million when estimated at "the national cost" (evaluating the cost of the expatriates on the basis of the average annual cost of the national scientists).

National AR expenditures (NE): 0.33% of the Agricultural Gross Domestic Product (AGDP: US\$ 120 million in 1996). Total AR expenditures estimated at "the national cost": 1.5% of the AGDP.

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF ETHIOPIA<sup>1</sup>

## 1. HISTORICAL BACKGROUND

The history of agricultural sciences in Ethiopia coincides with the establishment of the Ambo (AJCA) and Jima (JJCA) Junior Colleges of Agriculture in 1947, and of the Imperial College of Agriculture and Mechanical Arts in 1953, later called the Alemaya College (now University) of Agriculture (AUA).

Significant agricultural research (AR) activities started when the Alemaya College established a central experiment station at Debre Zeit, known at present as the Debre Zeit Agricultural Research Center (DZARC). Other field experiments were initiated during the 1963 crop season at Kuyera (near Shashemene) and at Addis Abeba; the major focus was screening for adaptability of selected crops and cultural practices. Varietal introductions and experimentation with dairy cattle and poultry were also conducted.

The inception of the Institute of Agricultural Research (IAR) in 1966 marked the beginning of organized AR and actual relations between agricultural research and development in the country. IAR was established with mandates to formulate the national AR policy; carry out AR on crops, livestock, natural resources, and related disciplines in various agroecological zones of the country; and coordinate national AR.

Another center, the Plant Protection Research Center (PPRC), which was established in 1972 and operated under the Ethiopian Science and Technology Commission, was merged with IAR in 1995. The Plant Genetic Resources Center of Ethiopia, which was founded in 1974, later became the Biodiversity Institute (BDI). Four other AR institutions were established later: the Forestry Research Center (FRC, 1975), the Wood Utilization Research Center (WURC, 1979), the National Soils Laboratory (NSL, 1989) and the Institute of Animal Health Research (IAHR, 1992).

Other institutions of agricultural higher education (AHE) were then created: Awasa College of Agriculture (ACA, established in 1977), Wendo Genet College of Forestry (WGCF, 1978), the Faculty of Veterinary Medicine at Debre Zeit of Addis Abeba University (FVMDZ, 1979), and Mekele University College (MUC, 1994).

In 1993, some IAR centers were decentralized to create independent research centers run by the respective regional governments, and became the Regional Agricultural Research Centers (RARCs) generally under their respective regional bureaus of agriculture.

In June 1997, the Ethiopian Agricultural Research Organization (EARO) was established and merged all the existing AR institutions (IAR, DZARC, BDI, FRC, WURC, IAHR and NSL) except the RARCs. EARO is affiliated directly to

## 2. THE CURRENT NARS

### 2.1 Overview

As of 1997/98, the Ethiopian NARS is made up of two main sets of institutions:

- The scientific institutions which have AR as their central mandate; they include all the former institutions which have been merged within EARO and the Regional Agricultural Research Centers (RARCs). These account together for 86% of the total potential research years (pRYs: equivalent full-time researchers) and 97% of the total financial resources of all the NARS. These institutions are presented in Sections 2.2 and 2.3.
- The institutions of higher agricultural sciences education actually involved in AR, which account for 13% of the pRYs and only 3% of the total financial resources of the NARS (see Section 2.4).

A few other institutions<sup>2</sup> allocate some resources to AR, but a precise inventory of their AR activities and resources is not available.

<sup>1</sup> Monograph based on information provided in 1998, just before the effective starting of EARO, by **Dr Getinet Gebeyehu**, former Deputy General Manager, IAR, and reviewed in 1999 by **Dr Tadesse Gebremedhin**, Advisor to the Director General, EARO.

<sup>2</sup> These are: (i) the National Herbarium (NPM) of the Biology Department of Addis Abeba University (AAU, established in 1959); (ii) the Ethiopian Nutrition Institute (ENI, 1962); (iii) the Institute of Development Research (IDR, 1972) under Addis Abeba University; and (iv) the Agricultural Development Department (ADD, 1980) of the Ministry of Agriculture, renamed as the Crop Production and Protection Regulatory Department.



Little or no AR work is done by the private sector. Although not members of the NARS, some international AR organizations are either represented through their branch offices in Ethiopia or they operate in close collaboration with NARS through their various networks. These are CIAT, CIMMYT, CIP, ICARDA, ICRAF, ICRISAT, and ILRI.

## 2.2 The AR Institutions Now Managed by EARO

These are the former Institute of Agricultural Research (IAR), which now constitutes the heart of EARO, and the other institutions generally considered as research units within EARO: the Debre Zeit AR Center (DZARC), the Biodiversity Institute (BDI), the Forestry Research Center (FRC), the Wood Utilization Research Center (WURC), the National Soils Laboratory (NSL), and the Institute of Animal Health Research (IAHR). All these institutions were previously affiliated to the Ministry of Agriculture (MOA), except DZARC which was run by Alemaya University of Agriculture (AUA). They meet together 64% of the pRYs and 79% of the total financial resources of the NARS.

### The Institute of Agricultural Research (IAR)

#### Mandate and Organization

IAR is the largest NARS institution (about 50% of the pRYs and 59% of the financial resources of the NARS). Since its inception, IAR has been a semi-autonomous research institution, functioning under the general supervision of a Board of Directors, the members of which are drawn from various ministries and organizations that are directly or indirectly involved in agricultural development in Ethiopia. AR is its central mandate and mobilizes almost all the time of its graduate staff.

It is headed by a Director General, who is assisted by a Deputy Director General for Research and one for Administration and Finance. The Head Office has technical and administrative support units. IAR had eight Federal Research Centers located in the different agroecological zones of the country, each one headed by a center manager who is assisted by commodity program leaders, sub-program leaders, and administrative and research support services. Now, under EARO, with the 5 units mentioned above, the number of research centers has increased to 13.

#### Human, Physical and Financial Resources

IAR currently (May 1998) has around 1901 national permanent full-time staff, consisting of 258 scientific and technical senior staff (43 PhD, 118 MS, 97 BS) (about 6% of whom are females); 166 technicians, which means a ratio of 0.6 technician to researcher, a rather low one compared to the general agreed upon standard (2); and 1477 other support staff (clerks, accountants, laborers, etc), with a ratio of 5.7 per researcher which is higher than the standard (34).

IAR operates through:

- its headquarters, located in Addis Abeba, which concentrate 6% of the scientific staff (not more than 0.8% of the PhD holders) and include the central offices and library;
- eight Federal AR Centers transferred from IAR (at Bako, Holetta, Jima, Pawe, Kulumsa, Ambo, Werer, and Nazareth), six sub-centers, and several testing sites spread across the various agroecological zones of the country. There are now also five research centers transferred from the Ministry of Agriculture (MOA) and AUA

program(s), but it is also responsible for specific regional research programs of the administrative region where it is located. It promotes and coordinates multidisciplinary commodity research at the national level. It also participates and collaborates with other national and regional research programs.

In general, research facilities, information services, and land resources (total: 1,800 ha) are considered inadequate. However, during the last 13 years, IAR has substantially improved its infrastructure, particularly in terms of office and laboratory space, laboratory equipment, farm machinery, and roads.

Financial resources (1997/98) amounted to Ethiopian Birr (ETB) 34.1 million (US\$ 4.9 million), coming mainly from national sources and from the government budget (ETB 30.9 million), with some external grants (ETB 3.2 million). For the last 10 years, national resources have steadily increased (US\$ 1.2 million in 1988, US\$ 2 million in 1993), but foreign grants have strongly decreased, especially after the completion of the National Agricultural Research Project (NARP), supported by the World Bank, which provided very large support to the institutional and physical development of the centers and sub-centers during the period 1987-1994.

In 1997, 35% of the national resources were allocated to salaries and 65% (ETB 20.1 million) to operation/capital costs (OCC). As most of the external grants are allocated to this second item, OCC amounts to around ETB 90,300 (US\$ 13,000) per graduate staff member, which is insufficient for covering the research needs (see Section 3.3).

#### Research Activities and Linkages

The largest number of researchers (72%) work on crop programs followed by livestock (19%) and natural resources (9%). This disparity in human resource distribution is further exemplified by the fact that 71% of the PhD, 73% of the MS, and 73% of the BS holders work on crop commodities alone. The corresponding figures are 9, 20, and 19% for livestock and 20, 7, and 8% for natural resources. The bulk of funds allocated to IAR went mainly to crop-related research because the government development plans and strategies emphasize food self-sufficiency. However, other sub-sectors such as livestock, natural resources, farm machinery, and agricultural economics should be given equal importance.

Most of the research centers are located in the major agroecological zones of the country. However, the arid and semiarid zones, mainly the northwestern and northern drought-prone sub-moist zones, and the eastern region of the country comprising western and eastern Harerge and the Somali and Afar regions, are least addressed.

Through the World Bank (IDA)/IFAD loan-supported Agricultural Research and Training Project (ARTP), research centers will be established at six sites: Jijiga in the Somali region, consisting of lowlands; Shiket in Afar region, hot to warm arid lowlands; Jinka in the southern region, hot to warm humid environment; Humera in Tigray region, hot and warm sub-moist to semiarid lowlands; Sekota in Amhara region, tepid to cool sub-moist environment; and Yavello in Oromia region, arid southern lowlands. These six new research centers will serve the agroecologies of the country which are not currently covered.

IAR had no formal linkages with the other NARS institutions. In the past, it organized a National Research Review Meeting that included all research centers, including those outside of IAR, such as the universities and development ministries, as well as other organizations engaged in AR. These meetings were held annually to review and approve research projects, particularly those of the IAR centers, as the universities or regional centers were not legally bound by decisions passed in the review system.

Collaboration exists with international research organizations through participation in projects executed in the country or involving other countries in the region. Some collaboration takes place through participation in networks; most of this collaboration was administered or handled by IAR, although other institutions also took part at all stages of planning, review, and execution of the research programs.

IAR, now EARO, has a long and fruitful experience in international cooperation which includes: (i) international AR centers (IARCs), where cooperation is generally in human resource development, germplasm exchange, consultancy services, and collaborative research in selected project areas; (ii) international or regional organizations which have supported and continue to support IAR in providing funds and technical assistance to further develop and strengthen IAR research programs; and (iii) bilateral arrangements. IAR also continues to have linkages with research institutions in developed and developing countries.

#### **Debre Zeit AR Center (DZARC)**

DZARC was formerly run by Alemaya University of Agriculture (AUA). It conducts research on crops (tef, durum wheat, chickpea, and lentil), forestry, and livestock (especially poultry), focussed mainly on the agricultural problems facing its surrounding area an extremely important agroecology endowed with fertile soils with research programs recently reoriented into an interdisciplinary team approach rather than a discipline approach.

It has 34 researchers (9 PhD, 19 MS, 6 BS). Its national financial resources amount to ETB 3.5 million (US \$0.5 million); foreign grants which were important in the past are now very limited (ETB 80,000). Total resources provide an average of around US\$ 15,000 per researcher, which is insufficient (see Section 3.3).

DZARC has close relations with the farmers of the area. When it was under AUA, it cooperated with IAR in research on sorghum, maize, haricot beans, groundnuts, dairy cattle, beef, soil, etc.

#### **The Biodiversity Institute (BDI)**

BDI was established in 1976 in response to the threat of genetic erosion mainly as a result of over-exploitation and the collection, evaluation, documentation, and research on crop germplasm in the country; (ii) conserving crop genetic resources using both *ex-situ* and *in-situ* strategies and providing germplasm for the development of improved crops; and (iii) acquiring new germplasm from other countries and documenting indigenous knowledge in the field.

BDI has 11 researchers (4 PhD, 7 MS). Its total financial resources amount to ETB 9.3 million (US\$ 1.3 million), of which ETB 2.3 million is funded by the Government and ETB 7 million are grants provided by foreign donors, and allow optimal working conditions.

Even before its restructuring within EARO, BDI had strong linkages with IAR. It has strong collaboration with international AR centers (IBPGR, ICARDA, etc.).

### **The Forestry Research Center (FRC) and the Wood Utilization Research Center (WURC)**

FRC and WURC conduct research on the conservation and development of forestry and sustainable utilization of forest products. Since their establishment, several adaptability trials, mainly of exotic species, have been launched nationwide. Research has been carried out on social forestry/ agroforestry and forest management. Agroforestry concentrates on off-farm and on-farm trials to test the adaptability and compatibility of multipurpose tree/shrub species with various crops and patterns of planting in different agroclimatic zones. Fuel wood consumption, fodder production, and a number of planting patterns have been studied.

The two centers employ 18 scientific and technical graduate staff members (1 PhD, 17 MS); the FRC graduate staff is fully committed to research, and the WURC staff is more oriented towards extension (around 15% of its time is allocated to research). Their budget amounts to around ETB 1.2 million (US\$ 0.17 million), which means an average of around US\$ 9,400 per graduate staff member, all costs included. These research centers, in their new capacity, will serve the agroecologies of the country which were previously not covered by research.

### **The National Soils Laboratory (NSL)**

NSL, established in 1989 in Addis Abeba, is mandated to render laboratory services for research, development, and educational establishments. It has 6 scientific and technical graduate staff (2 PhD, 3 MS, 1 BS) in the field of soil sciences (pedology, plant nutrition, etc.).

### **The Institute of Animal Health Research (IAHR)**

IAHR, established in 1992 in Sebeta, devises an effective and sustainable animal health management system to assist the sector in achieving its potential level of production and productivity, duly contributing to the national economy and public health.

They are to acquire sufficient and reliable information on animal health problems; develop new control and diagnosis techniques; assess and evaluate the existing animal health diagnosis, control, and surveillance methods; test, evaluate, and adapt new control and diagnostic technologies developed elsewhere before use in Ethiopia; and devise appropriate methods for transferring control and diagnosis research output to the end user. IAHR has 17 scientific and technical graduate staff (12 MS, 5 BS).

## **2.3 The Regional Agricultural Research Centers (RARC)s**

The nine RARC)s are the second largest of the NARS institutions, accounting for about 22% of the pRYs and 17% of the financial resources. They are located at Adet, Sheno, and Sirinka in the state of Amhara; Adami Tulu, Bako, and Sinana in the state of Oromiya; Awasa and Areka in the Southern Ethiopia Peoples Administrative Region (SEPAR); and Mekele in Tigray Administrative Region. They are administratively accountable to the Regional Agricultural Bureau and technically to EARO. Each RARC is headed by a center manager who is assisted by program and sub-program leaders and administrative and research support services.

The RARC)s have 131 graduate staff members (5 PhD, 42 MS, 84 BS)<sup>1</sup>. They are funded (budget: ETB 11.2 million or US\$ 1.6 million; i.e., US\$ 12,200 per graduate staff member) by the respective regions, except for national research projects, in which they collaborate with the EARO Federal AR Centers.

The RARC)s conduct research that addresses the specific needs of a particular region. They promote multidisciplinary research at the regional level and have research activities. They also participate in collaborative national research programs in any one or more of the crop, livestock, and natural-resource commodity programs.

<sup>1</sup> 47 researchers (including 1 PhD and 14 MS) in Adet (crops), Sheno (small ruminants, crops), and Sirinka (natural resource management, crops) in the state of Amhara; 59 res. (including 1 PhD and 19 MS) in Adami Tulu (livestock), Bako (crops, livestock), Sinana (crops) in the state of Oromiya; and 25 res. (including 3 PhD and 9 MS) in Areka (crops) and Awasa (crops) in SEPAR.

## 2.4 The Institutions of Agricultural Sciences Higher Education (AHE)

The primary function of higher learning institutions is teaching, with research representing an important component in some of them. Included under these are:

- Alemaya University of Agriculture (AUA), with one AR centers affiliated to it (Alemaya). It is a chartered university run by a Board whose chairperson is the Minister of Education, and the secretary is the President of the University. It is the largest agricultural higher learning institution, with 106 academic staff members (asm), including 23 PhD and 61 MS; it offers BS and MS degree programs.
- Three colleges<sup>1</sup>: Awasa College of Agriculture (ACA) (47 asm, including 11 PhD and 30 MS holders); Mekele University College (MUC) (21 asm, including 1 PhD and 19 MS holders); and Wendo Genet College of Forestry (WGCF) (22 asm: 5 PhD and 17 MS holders)<sup>2</sup>. Each college, which evolved from a small capacity establishment, is now able to enroll students for BS degree programs.
- The Faculty of Veterinary Medicine at Debre Zeit (FVMDZ, 1979) of Addis Ababa University (57 asm, including 10 PhD and 20 MS holders), where 15 research projects are conducted at present (1997/98).

These five AHE institutions employ 253 academic staff members (50 PhD, 147 MS, 56 BS). Their financial resources came only from the government budget and were very limited; however, in 1997/98 these resources were more favorable, amounting to ETB 6.6 million (US\$ 0.94 million) from the Government and ETB 5.4 million (US\$ 0.77 million) from external sources, which means US\$ 6,800 per asm for all the training and research activities.

## 3. AR RESOURCES

### 3.1 Human Resources

The NARS employs 728 graduate scientific and technical staff members (114 PhD, 365 MS, 249 BS), mostly national, who represent 475 pRys (see [Table 1](#)).

The salaries of graduate scientific and technical staff members at EARO and at the universities are comparable, with a slightly better advantage for EARO staff. For example, in 1996, monthly salaries of senior researchers at IAR were ETB 2330 (US\$ 330), and of graduate research assistants and technicians ETB 1530 (US\$ 220) and ETB 600 (US\$ 90), respectively. At the universities, e.g., AUA, the monthly salaries ranged between ETB 2,000 (US\$ 290) for a professor, ETB 1,300 (US\$ 190) for a lecturer, and ETB 470 (US\$ 70) for a technician (and lower for less skilled labor) compared to the respective salaries of ETB 1,440, 1,000, and 420 for national civil servants, and ETB 5,000, 2,500, and 800 in the private sector.

In 1996/97, the Government approved and implemented a new career structure for AR scientists that has boosted the morale of all professionals in AR.

### 3.2 Physical Resources

A limited number of facilities such as residential buildings, offices, laboratories, seed stores, and cold rooms have been constructed in several major research centers, and farm machinery, agricultural implements, motor vehicles, and office and laboratory equipment were made available to some major centers from various sources: IDA, UNDP/FAO, the Netherlands/ICARDA, and the Ethiopian Government. However, many of the equipment and vehicles are old and have been kept working beyond reasonable service life, thus resulting in frequent breakdowns and high maintenance cost. All research centers are not well equipped and this has hampered their operation and reduced the amount of off- and on-station work.

<sup>1</sup> The Ambo and Jima Junior Colleges of Agriculture are not taken into account in this monograph as they are not offering graduate studies and are not involved in AR activities.

<sup>2</sup> WGCF was established in 1978 for diploma-level training in forestry. It then started training at the BS level in 1996 and developed a joint MS program with the Swedish University of Agricultural Sciences. It is governed by a Board under the Ministry of Education. Currently, the college staff is conducting 13 research projects in various forestry programs, soil conservation, community forestry, and agroforestry practices, with adequate teaching and research facilities now available. In 1997/98, WGCF received a budget of US\$ 0.32 million from the Ethiopian Government and US\$ 2.69 million from Sweden for capacity building.

Attempts have been made to build laboratories in most research centers, yet none of them can serve as a referral laboratory. A few run at full capacity despite the fact that they house old equipment. Some, like Areka, have only laboratory space provision, with nothing as much as a test tube. The same holds true for most of the centers in terms of libraries, greenhouses, seed and chemical stores, etc.

The status of motor vehicles and farm equipment in most of the centers is also quite discouraging. While some centers are fairly equipped with office equipment like computers and printers, some have none. As regards laboratory facilities, Holetta, Alemaya, and Debre Zeit are in a better position, while a few conduct some analyses and the majority lack the basic laboratory facilities. However, now, through the Agricultural Research and Training Project (ARTP), the facilities of almost all the research centers are expected to be improved.

### 3.3 Financial Resources (see Table 1)

Total financial resources allocated to AR at present (1997/98) by the Ethiopian NARS are ETB 58.1 million (US\$ 8.3 million) per annum. They are made up of:

- ETB 47.6 million of national origin, mainly from the national treasury, and partly from the income resulting from experimental station produce sales;
- ETB 10.5 million from external sources, in the form of small grants from the World Bank/IFAD, UNDP/FAO, EU, IDRC, the Netherlands, and Sweden. These resources are used mainly for human resource development, technical assistance, laboratory supplies, field facilities, and vehicles.

National AR and total expenditures represent 0.20 and 0.24%, respectively, of the Agricultural Gross Domestic Product (AGDP, estimated at US\$ 3.4 billion in 1996). Such ratios are much lower than the 1% recommended by some international organizations (World Bank, European Union, etc.).

Areas of expenditure vary considerably between the NARS institutions; however, in most of the institutions, the available OCC is relatively low and inadequate for allowing satisfactory conditions of work, except for BDI. At IAR, OCC per graduate staff member amounts to US\$ 13,000, which represents around US\$ 14,000 per pRY<sup>1</sup>; in the other ARs, this number may not exceed US\$ 8,000 per pRY. Such numbers 25,000/30,000 per pRY used by many developing countries in drawing up long-term plans, which means that the AR scientific potential in the Ethiopian NARS is currently far from being fully mobilized.

According to this last reference, IAR should have roughly around 130 actual RYs (50% of its pRYs) and the other AR institutions around 65 actual RYs (30% of the pRYs). As seen above, the institutions of higher agricultural sciences education are even less endowed and may hardly represent 25 actual RYs. Therefore, the NARS may mobilize roughly a total of 220 actual RYs, instead of the 475 pRYs estimated above.

## 4. RESEARCH ACTIVITIES

### 4.1 Research Orientation and Coordination

In the early 1990s, efforts to formulate and implement a national AR policy were not sustainable, largely due to the lack of sufficient political commitment and the necessary resources. These efforts have been re-initiated with the establishment of the National Agricultural Research Council (NARC), operating under the auspices of the Ethiopian Science and Technology Commission (ESTC). NARC was the main body for implementing the AR policy and strategy of the country and coordinating research at the national level. It was mandated to promote and support AR at the federal as well as the regional level for about two years. These responsibilities have been taken over by EARO after its establishment in 1997/98.

Research coordination occurs at two levels: interdisciplinary and inter-institutional. The diversity of the Ethiopian agroecologies and the limited human and material resources call for a multidisciplinary approach. Interdisciplinary coordination in the Ethiopian NARS has become important, especially after the research programs were organized by commodities in 1979, and has been operational since then. This seems to be working relatively well although there is a need for establishing a mechanism for recognizing the contribution of all disciplines in an equitable manner.

<sup>1</sup> As the number of pRYs is lower than the number of graduate staff members, and part of the OCC is allocated to other activities than research (see Table 1, note n).

Annual professional conferences such as the National Crop Improvement Conference (NCIC) have helped in the past, where they provided a forum for exchange of ideas on agricultural research and development, and in minimizing duplication of efforts by different organizations. NCIC was also instrumental in the creation of the Ethiopian Seed Enterprise (ESE) and the National Variety Release Committee. This organization is almost defunct at present.

Over the last quarter century, several initiatives have been launched to improve the functioning, organization and coordination of agricultural research in IAR. These initiatives have resulted in well-coordinated, organized, and functionally improvable and long-lasting research foundations through a number of contemporary approaches.

National Commodity Research (NCR) involves all commodities that have been given national priority. NCR is organized and coordinated by national commodity research teams. Each team is composed of researchers drawn from different specializations. NCR acquires its annual budget from the Government or from special funds administered by EARO. In its technical and administrative function, NCR is semi-autonomous and hence its accountability is to EARO management. The NCR programs are coordinated at research centers where the commodity, as a biological organism (crop), is dominant in the locality and where facilities (human and material resources) are relatively adequate. NCR experiments are executed in EARO and non-EARO institutions.

For crops that are not yet promoted to commodity level, researchers are also organized in teams. In principle, the organization of these teams is similar to that of NCR except that they are thinly stretched and their autonomy is minimal. The non-commodity teams and disciplines that are not part of NCR are functionally organized and coordinated by centers or departments. However, under EARO, all research programs have been promoted to commodity status.

Research is undertaken by several departments in the different research centers, sub-fields. The Research/Extension Liaison Committee (RELC), represented by regional offices of MOA and farmers, was an important forum for discussing and exchanging ideas on production constraints, research programs, and research findings. Recently, the Input Coordination Unit replaced RELC as an important interface between research and extension at all levels of the government structure. Research/extension farmer linkage councils are recently being established at zonal and center levels to strengthen these linkages.

Both NCR and the departments are engaged in many experiments, usually more than 1,000 annually, involving crops, livestock, agricultural mechanization, natural resources, and agricultural economics.

EARO management provides centralized and decentralized technical and administrative assistance in support of NCR and other research programs.

There were no research institutions for fisheries, but at present, the fisheries program of MOA has been transferred to EARO and is included as a national research commodity.

#### **4.2 Relations with Development**

With the broad objectives of AR in Ethiopia, the technological opportunities offered by research give AR a central role in changing the livelihood of the people and supporting the Agriculture-Led Industrial Development (ALID) plan of Ethiopia. This is based on the assumption that AR is a major mechanism for growth in agriculture, that there is a close liaison between research and development, and that policies and strategies will stay on track.

#### **4.3 Cooperative Relations**

Partnerships exist among the different NARS institutions and between them and international organizations. On a national level, partnerships exist between EARO, AUA, ACA, MOA, ESE, Regional Research Centers, ESTC, and SG 2000. On an international level, cooperative relations exist with CIAT, CIDA, CIMMYT, CIP, IBSRAM, ICARDA, ICRAF, ICRISAT, ILRI, the EU, and the World Bank.

### **5. CONCLUSION**

The need for coordination of the NARS has been felt since the establishment of IAR in 1966. Although IAR was mandated to coordinate research at the national level, its accomplishment in this respect has not been satisfactory, primarily because it did not have the means to enforce the rules; IAR had the technical know-how but budget allocation and release was done by an outside institution.

Initiatives have been taken by the Government in recent years to strengthen inter-institutional coordination. The issuance of the National Agricultural Policy in 1993 and the subsequent establishment of the Ethiopian Agricultural

Research Organization (EARO) by the Ethiopian Government in 1997 are expected to resolve that problem. Major tasks of EARO include developing agricultural policies, coordinating agricultural research on a national level, and advising the Government on matters relating to agricultural research and development. As of 1997/98, the different AR dination.

One of the major bottlenecks of NARS has been the problem of retaining qualified staff, mainly due to the poor salary scale and incentives. The Federal Government of Ethiopia has recently upgraded the salary scale of researchers and lecturers as a step to improve their status and attract them. In addition, the Government has launched a program to improve the trained manpower status by opening additional faculties and colleges. It is also sponsoring staff abroad in various fields.

The Ethiopian Government has formulated a national science and technology policy in the major economic sectors, including agriculture. In order to encourage science and technology, the Government has committed itself to allocating up to 1.5% of the GDP to these activities.

The Economic Development Policy of Ethiopia has given the highest priority to agriculture under the aegis of an agriculture-led industrial development. In an effort to raise the productivity of the agriculture sector and to be self-sufficient in food production, the Government has recently formulated the National Agricultural Research Policy which focuses mainly on generating technologies that will enable improving agricultural production in quantity and diversity. Other supporting tools have been the formulation of the National Seed Industry and National Fertilizer Policies.

#### Main Acronyms

**MOA:** Ministry of Agriculture. **NARC:** National Agricultural Research Council. **NCIC:** National Crop Improvement Conference. **NCR:** National Commodity Research. **RELC:** Research Extension Liaison Committee. **SEPAR:** Southern Ethiopia Peoples Administrative Region. **SG 2000:** Sasakawa Global 2000.

**AAU:** Addis Abeba University. **ACA:** Awasa College of Agriculture. **AUA:** Alemaya University of Agriculture. **BDI:** Biodiversity Institute. **EARO:** Ethiopian Agricultural Research Organization. **FRC:** Forestry Research Center. **IAHR:** Institute of Animal Health Research. **IAR:** Institute of Agricultural Research. **WURC:** Wood Utilization Res. Center.

**ETB:** Ethiopian Birr.

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Table 1 - The National Agricultural Research System: Synthesis Table (1997/98)

*Italics*

NARS Institutions				Scientific & Tech. Graduate Staff (Units)				Potential Research Years			Total Budget (1000 ETB)		AR Expendit./Resources (E) (1000 ETB)				
No.	Name - Acronym Head Office - Year Established		Mandates AR Fields	Gover. Minist.	Nationals Total - (PhD , MS)		Exp.	Total	Nat.	Ext	Total	Nat.	Ext.	Nat. NE	For. FE	Total TE	
a	b		c	d	e	f	g	h	i	j	k	l	m	n	o	p	
1.1	Institute of Agric. Research - Addis Ababa	IAR - 1966	AR - All exc. cot., tobac.	MOA	258	43 , 118		258	306*	306		30,900	3,200			46,200	
1.2	Debre Zeit Res. Center - Debre Zeit	DZARC - 1953	AR - Crop, liv., natural res.	EAARO	34	9 , 19	34	3,500				80					
2.1	Biodiversity Institute - Addis Ababa	BDI - 1974	AR - Crop genetic res.	EAARO	11	4 , 7	11	2,330				6,960					
2.2	Forestry Research Center - Addis Ababa	FRC - 1975	AR - Forestry	EAARO	18	1 , 17	18	890									
2.3	Wood Utilization Research Center - Addis Ababa	WURC - 1979						320									
2.4	Institute of Animal Health Research - Sebeta	IAHIR - 1992	AR - AD - An. health	EAARO	17	0 , 12	17	350									
2.5	National Soils Laboratory - Addis Ababa	NSL - 1989	AD-(AR) - Soil, fertil.	EAARO	6	2 , 3	6	250									
A	Total actually under EAARO		EAARO - 1997/98	AR (90%)	PMO	344	59 , 176	0	344	306*	306					46,200	
B	Regional Agricultural Research Centers		1969, 1993	AR (80%)	RBA	131	5 , 42	131	105		105	11,200				10,100	
1/2	Total AR Institutes					475	64 , 218	0	475	411	0	411	49,750	10,200	46,600	9,700	56,300
3.1	Alemaya Univ. of Agriculture - Alemaya	AUA - 1953	AHE - (AR) All	ME	106	23 , 61	5	111	27	1	28	2,920		440		440	
3.2	Awasa College of Agr. (Ad. Ab. Univ.) - Awasa	ACA - 1977	AMHE - (AR) All	ME	47	11 , 30		47	12		12	1,080		160		160	
3.3	Mekele University College - Mekele	MUC - 1994	AHE - (AR) All	ME	21	1 , 19		21	5		5	140		20		20	
3.4	Wendo Genet College of Forestry - Wendo Genet	WGCF - 1978	AHE - (AR) Forest.	ME	22	5 , 17		22	5		5	2,200	3,800*	330	570	900	
3.5	Fac. of Vet. Med. - Debre-Zeit (Addis Ab. Univ.)	FVMDZ - 1979	AHE-(AR)- An. prod./heal.	ME	57	10 , 20		57	14		14	290	1,550	40	230	300	
3	Total Agr. Sciences Faculties/Colleges					253	50 , 147	5	258	63	1	64		5,350		800	
4	Other Institutions (see Section 2.1, footnote 2)																
5	Total NARS					728	114 , 365	5	733	474	1	475	56,350	15,550	47,600	10,500	58,100
Exchange Rate : ETB 1 = US\$ 0.143 (1998 average rate)					Actual Research Years (aRY) (Estimate) -->					220			AR Expendit. (US\$ million)		6.8	1.5	8.3

MOA: Ministry of Agriculture, ME: Ministry of Education, EAARO: Ethiopian Agricultural Research Organization, PMO:

RBA: Regional Bureaus of Agriculture

c: Mandates: AR (%): Approximate average % of human resources devoted to ag. research (AR); R: Research; AHE: Ag. higher education; AD: Ag. development/services (for AR and AHE institutes: seed production, soil and water analysis, extension, studies, etc.). j, k, l: Potential research year (pRY) = equivalent full-time researcher; for EAARO, the pRYs have been estimated by multiplying the number of graduate staff by the percentage of their time allocated to AR activities, roughly estimated by 90% for all institutions, except for NSL: 25%; for the FASs, the pRYs have been estimated by multiplying the number of academic staff by 0.25. n: For the AR ins

the % of time devoted to AR by the graduate staff. 3.4\*: Assuming that the US\$ 2.69 million received by WGC from Sweden for capacity building in 1997/98 is over a 5-year period.

National AR expenditures (NE): 0.20% of the Agricultural Gross Domestic Product (AGDP; US\$ 3.4 billion in 1996). Total AR expenditures (TE): 0.24% of the AGDP.

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF SUDAN<sup>1</sup>

## I. HISTORICAL BACKGROUND

**Agricultural research (AR)** in Sudan dates back to the turn of the century. Formal AR began in the northern province in 1902 and near Khartoum in 1903 to explore the possibilities of growing cotton under irrigation. This was followed shortly by similar work at Rumbek and Wau, in the south, for rain-grown cotton. The Wellcome Tropical Research Laboratories were established in Khartoum in 1903, with emphasis on medical research, but they also conducted chemical and entomological research related to agriculture. Botanical and agricultural research started in 1904 at Shambat Research Station. Pilot schemes and experiments by the Sudan Plantation Syndicate showed that cotton could be grown successfully on a commercial scale in the Gezira area. This promoted the establishment of Gezira Research Station in 1918. In 1931, the Agricultural Research Service was formed as an independent body, and in 1935, it was absorbed into the Department of Agriculture and Forests. In 1944, the new Agricultural Research Division (ARD) was established.

Research on animal health started in 1913 following the creation of the Central Veterinary Research Administration (CVRA) in Khartoum. Research on fisheries and on animal production was initiated with the establishment of the Fisheries and Marine Biology Center at El Shagar in 1953 and of the Animal Production Administration (APRA) in 1955, respectively.

After independence in 1956, ARD expanded rapidly (new research stations created at Hudeiba, Sennar, Maatug, Kenana, Guneid, etc.) to encompass activities in different crops and ecological zones in the country. To ensure the technical and productive efficiency of research activities, ARD was made semi-autonomous in 1967 and became the Agricultural Research Corporation (ARC), affiliated to the Minister of Agriculture and Forests. In 1975, ARC considerably broadened its mandate, merging the Forest Research Center Institute (created at Soba in 1962), the Fisheries and Marine Biology Center, the Food Research Center (established in Shambat in 1965 with FAO support), the Pasture and Range Research Section (of the Range and Pasture Management Administration), and the Game and Wildlife Research Station (of the Department of Wildlife and Game).

In 1970, a formerly created Veterinary Research Division became the Veterinary Research Laboratories Administration (VRLA) within the Central Veterinary Research Administration (CVRA), established at Soba (with FAO support), and five regional laboratories (Sennar, Nyala, El Obied, Kassala, Juba).

Also in 1970, the National Council for Research was established to formulate and supervise the national research policy<sup>2</sup>, and to fill in gaps in research not tackled by existing research institutes. In 1991, the Ministry of Higher Education and Scientific Research (MHESR) was set up. Accordingly, in 1992, the National Council for Research was converted into the National Center for Research (NCR), affiliated to MHESR, to carry out research work only. It still heads six research institutes, among which three are AR related: the Environment and Natural Resources Research Institute (ENRRI), the Aromatic and Medicinal Plant Research Institute, and the Remote Sensing Institute (previously an ENRRI department).

In 1996, APRA and CVRA (two directorates of the Secretariat for Animal Resources) were merged to form the Animal Resources Research Corporation (ARRC) as a semi-autonomous public institute under the Ministry of Animal Resources (MAR), responsible for research on livestock and also on fisheries and wildlife (previously under ARC).

**Agricultural higher education (AHE)** began with the establishment in 1938 of the School of Agriculture of Shambat and the Veterinary School of Khartoum. In 1951, these schools were incorporated into the University College of Khartoum, also established in 1951, which then became the University of Khartoum (UK) in 1956, and were renamed as the Faculty of Agriculture and the Faculty of Veterinary Sciences, respectively.

During the period 1954–84, nine new AHE and AR-related HE units<sup>3</sup> were established: (1) four within UK (the Faculties of Forestry and Animal Production, created from the two existing faculties—Agriculture and Veterinary Sciences; the Department of Agricultural Engineering within the Faculty of Engineering; and the Institute of Environmental Study); (2)

<sup>1</sup> By **Dr Osman Ageeb**, former Director General, ARC (until October 1998); **Dr Abdalla M. Hamdoun**, Professor, Faculty of Agricultural Sciences, University of Gezira; and **Dr Hassan Salim El-Hassan**, Director of External Relations, ARC.

<sup>2</sup> NCR had five sub-councils, one of which was the Agricultural Research Council, which did not have its own facilities, but provided funding to institutions, teams or individual scientists to conduct AR activities.

<sup>3</sup> The Department of Agricultural Engineering within the Faculty of Engineering of UK and the Institute of Environmental Study, also within UK, are only partly related to AR.

two within the Sudan University of Science and Technology (SUST) in Khartoum (the College of Agricultural Studies, CAS, which took over in 1975 a technicians' training institute established in 1954, and the Faculty of Animal Production created in 1984 from a former branch of CAS), (3) two within the University of Gezira (the Faculty of Agricultural Sciences, and Abu Haraz Faculty of Agriculture and Natural Resources, both at Wad Medani), and (4) one within the University of Juba (the Faculty of Natural Resources and Environmental Studies).

During the last six years, the national AHE system (NHAES) has witnessed dramatic changes, accentuated by the new federal organization of the country (creation of 26 states in 1995): 11 additional agriculture, veterinary, and animal production faculties and colleges have been established in new universities; other faculties are projected (each state would like to have its own faculty of agricultural sciences). The older faculties are giving more attention to higher-degree education and are supporting the new faculties. The Government has just set up an ad hoc committee mandated to assess the situation and to elaborate proposals for mastering the expensive and rather anarchic expansion of the NHAES.

## 2. THE CURRENT NARS

### 2.1 Overview (see Table 1)

The NARS currently includes two main sets of scientific institutions:

- The scientific institutes or units mainly involved in AR: the Agricultural Research Corporation (ARC), the Animal Resources Research Corporation (ARRC), three research institutes within the National Center for Research (NCR), and the Hydraulic Research Station of Gezira, respectively within the governance of the Ministry of Agriculture and Forestry (MAF), the Ministry of Animal Resources (MAR), MHESR, and the Ministry of Irrigation (MI). These units, presented in Section 2.2, gather around 67% of the potential research years (pRYs or equivalent full-time researchers) and 92% of the total financial resources of the whole NARS.
- The faculties and colleges of agricultural sciences (all agriculture specialties in Sudan, including marine fisheries/oceanography), which are affiliated to MHESR: they represent together around 29% of the pRYs and 6% of the financial resources of the NARS (see Section 2.3).

Some other institutions for which AR activities represent a relatively small part of their mandate fill the remaining marginal place in the NARS; they are briefly presented in Section 2.4.

MHESR is mandated with defining and implementing the national scientific research policy; however, it has very limited influence on the NARS institutions affiliated to other ministries. So far, there is no national body actually responsible for the national AR policy; accordingly, this policy remains split among the NARS institutions and their governing ministries, and subjected to the personal links of their leaders.

### 2.2 The Agricultural Research Institutes (see Table 1)

#### Agricultural Research Corporation (ARC)

##### Mandate and Organization

ARC is the major institution of the Sudanese NARS (around 36% of the pRYs and 62% of the financial resources of the NARS). Its research activities are focussed mainly on crops, land and water, forestry, forage, pasture, and food processing in different agroecological zones. Although their primary function is to conduct AR, ARC researchers allocate only around 70% of their time resources to this activity. The remaining is directed towards extension (15%), teaching, training, and consultancies.

Wad Medani hosts ARC headquarters, two national centers, two national laboratories (pesticides, tissue culture), a genetic resources unit (genebank), and a seed production unit. Research is coordinated by 12 coordinators for commodity programs and two for disciplinary programs (socioeconomics, agricultural engineering), and the directors of the four centers (soil/water and crop protection based at Wad Medani, forestry and food processing based at Khartoum).

##### Human, Physical and Financial Resources

ARC currently (January 1998) has 3195 national permanent full-time staff, of whom 303<sup>1</sup> are scientific and technical graduate staff on duty<sup>1</sup>, 600 technicians, 400 clerks, accountants and storekeepers, and 1892 laborers (certainly too

<sup>1</sup> Against 14 scientific and technical senior staff members in 1960 and 160 in 1980.

numerous). Among the 303 graduate staff, 97, 126, and 80 hold PhD, MS, and BS degrees, respectively; and represent around 212 pRys<sup>2</sup>. About 25% of the senior staff are females.

ARC has been suffering a strong turnover of its scientific staff over the years (more than 20 researchers have left ARC during the period 1992–97, most of them for positions in Arab countries). This brain drain is partly justified by the low salaries provided by the Government (see Section 3.1).

With regard to the distribution of researchers in the various agricultural production systems, 38% are serving the modern irrigated sector (which produces all the cotton and sugar, 80% of the wheat, 40% of the groundnuts, 15% of the sorghum, and 70% of the vegetables); 25% the rainfed sector (which produces 85% of the sorghum, 60% of the groundnuts, and all the sesame, millet, gum Arabic, fuel and furniture wood); and 15% the irrigated traditional small holdings (all the cool-season legumes and date palms, 20% of the wheat, and 30% of the citrus). The remaining 22% are engaged in other research domains: natural resources (soil, water), genetic resources, tissue culture, pesticides, and food technology.

The territorial distribution of researchers is rather uneven: 80 and 61 senior researchers are concentrated in Gezira Research Station and the Khartoum units, respectively, while the remaining are thinly spread over 18 other research stations (17 regional stations and Guneid Sugarcane Station; 15 of the stations have an average of only 4 researchers) mostly located in the rainfed regions which are the poorest of the country and do not have the critical mass for meeting the regional AR needs. Some efforts have been undertaken for insuring a better territorial distribution of the staff, but conditions of life and work in remote areas are not attractive.

Research is supported, to a large extent, by adequate, appropriate, and fully operational experimental fields (total area: 2,500 ha), satisfactory but outdated laboratories and equipment, moderate application of modern computer facilities for resource management and for research. Highly specialized research equipment is centralized at Gezira and Khartoum; the 18 research stations cover key agroecological zones, but most of them are poorly equipped. This relatively satisfactory situation is due to the large financial support received through grants (USAID, the Netherlands) and loans (the World Bank and IFAD)<sup>3</sup> during the period 1979–95.

In 1997, the total resources of ARC amounted to LS 3,600 million (US\$ 2.3 million), funded mostly by the country (LS 3,300 million, provided essentially by the Government, of which 1,850 was for salaries/allowances and 1,450 for operations<sup>4</sup>), and by external grants (LS 300 million). These resources are mostly allocated to research activities; the available operational/capital funds, estimated at around LS 7.1 million (US\$ 4,470) per pRy, are very low and indicate that: (i) researchers are far from getting the necessary resources for working actually full-time on research and may be largely underemployed; and (ii) ARC is not able to find the maintenance or replacement of its capital (buildings, equipment).

### Research Activities and Linkages

Among the research programs, irrigated crops (49 researchers, including wheat: 7, maize: 2, cotton: 14, sugarcane: 5, vegetables: 14, fruits: 7), crop protection (44 res.), land and water (36 res.), food processing (21 res.), and forestry (20 res.) receive the highest attention. Rainfed crops (millet: 2, groundnuts: 5, sorghum: 5), range/forage (3), and economics (10), are understaffed and will be reinforced. Farming system research has been recently introduced (in the eastern part of the country). The priority-setting exercise recently conducted<sup>5</sup> will help establish better equilibrium among these programs.

ARC has few collaborative research projects with other NARS institutions. Numerous informal linkages with faculties of agricultural sciences are concentrated on teaching and some supervision of graduate students. Linkages with external scientific and funding institutions were well developed in the past years (the Netherlands; USA; international and regional AR centers; World Bank; IFAD; FAO; etc.), but are currently weak and insufficient (political reasons). Present linkages with ICARDA, ICRISAT, IPGRI, CIMMYT, ASARECA, etc. are highly

<sup>1</sup> Among the senior staff on duty, around 70 are on study courses in Sudan; ARC staff also includes 17 researchers on study courses abroad, 15 researchers on secondment to other institutions (of whom 7 are abroad), and 15 researchers on leave without pay.

<sup>2</sup> 303 graduate staff members on duty  $\times$  70% (percentage of their time allocated to AR).

<sup>3</sup> The joint USAID/World Bank Western Agricultural Savannah Research Development Project, implemented during the period 1979–85 afforded the full renovation of the research station of El-Obied. The Agricultural Research, Training and Extension Project (1986–93), funded (loan) by the World Bank, was centered on the Central Region and benefited principally the ARC stations of Gezira, New Halfa and Rahad, and also the Faculty of Agricultural Sciences of the University of Gezira.

<sup>4</sup> No expenditure for equipment in 1996 and 1997.

<sup>5</sup> Based on the analysis of the challenges facing agricultural production in the country (economic importance of the commodity branches, food security, export potential), experience and available information.

appreciated. Efforts are now being made to strengthen internal and international linkages, especially after the creation of an External Relations Directorate within ARC.

## **Animal Resources Research Corporation (ARRC)**

### Mandate and Organization

ARRC is responsible for all research in animal production, health and feeding, wildlife, and fisheries. Around 65% of its research staff's time is allocated to AR, and the remaining to development (epidemiological surveys/diagnosis, vaccine production, biological analysis, etc.), consultancies, teaching, and training. It has four research centers:

- the Central Veterinary Laboratory Research Center (CVLRC), which specializes in animal health and includes the former VRLA facilities, with the research complex of Soba (several departments and supporting units: pathology and epidemiology of various animal diseases, assessment of drugs, vaccine production) and six regional research laboratories;
- the Animal Production Research Center (APRC), which includes the former APRA facilities, with the research complex of Kuku near Khartoum North (five departments: animal breeding, animal nutrition, meat production and technology, dairy production, poultry production) and five regional research stations;
- the Fisheries Research Center supported by four research stations (Red Sea, White Nile, Lake Nubia, Shagara); and
- the Wildlife Research Center with five regional stations in the major national parks and game reserves.

### Human, Physical and Financial Resources

ARRC currently (1998) has 305 national permanent full-time staff consisting of 225 scientific and technical graduate staff (50 PhD, 155 MS, 30 BS, 10 of whom are on secondment), who represent around 146 pRYs. It is suffering from excessively high concentration in Khartoum (over 90%), large turnover of its senior staff, and acute lack of qualified technicians (30) and other support staff (50).

The current state of the infrastructure (centers and stations) and equipment is moderate but outdated. The stations/farms cover 500 ha and are too split in the country.

In 1997, ARRC budget amounted to around LS 2,000 million (US\$ 1.26 million), coming from government (90%) and self-generated sources (no external grants in 1997; less than LS 0.2 million in 1996). Expenditures cover salaries and allowances (LS 940 million) and operational/equipment costs (LS 1,060 million, more or less equally distributed between research activities and production of vaccines). The AR budget represents roughly LS 1,100 million, with an operational/equipment budget of LS 530 million, i.e., LS 3.6 million (US\$ 2,270) per pRY, which implies very large underemployment of the staff, and the current impossibility to maintain or rehabilitate the central and regional facilities.

### Research Activities and Linkages

Priority research on animal health (121 graduate staff based at Soba/Khartoum, few others in the six regional laboratories) covers diagnosis and research in epidemic diseases of livestock, and research and production of vaccines. Research on animal production (48 graduate staff at Kuku/Khartoum, few other in the five regional stations) cover mainly livestock feed resources and animal breeding (characterization and upgrading of the indigenous breeds of cattle, sheep, goats and camels). Research on fisheries (5 researchers) and wildlife (6 researchers) are respectively directed to freshwater and marine aquaculture and fisheries, and mapping of wildlife resources and studies on conservation of endangered species. However, few research programs are currently active due to the lack of financial resources and technicians.

ARRC has numerous informal linkages with other NARS institutions (faculties of agricultural sciences, especially the faculties of veterinary sciences; ARC; etc.), but no actual collaborative research programs. Past linkages with external scientific and funding institutions (Ford Foundation, ACSAD, AOAD, ILRI, UNDP, FAO, etc.) are currently very weak.

## **AR-Related Institutes of the National Center for Research (NCR)**

Three NCR institutes are mainly involved in AR: the Environment and Natural Resources Research Institute, the Medicinal and Aromatic Plant Research Institute, and the Remote Sensing Institute.

The Environment and Natural Resources Research Institute (ENRRI) - ENRRI allocates around 60% of its resources to AR, and 40% to teaching, training, extension, etc. It has 109 national permanent full-time staff (1998), of whom 32 researchers are on duty (3 PhD, 20 MS, 9 BS), representing 19 pRYs. It is organized into five departments: Desert and Dry Land Research (soil and water, crop breeding, irrigation, etc.: 6 scientists), Biofertilization (5 sc.), Integrated Pest Management (8 sc.), Animal Resources/Fisheries (8 sc.), and Environmental Pollution Studies (5 sc.).

Research activities and results at ENRRI are very limited because of

- Its small number of technicians (19, among whom 10 are preparing BS degrees and soon leaving their technician status) and clerks/laborers (48);
- Its very poor physical resources (one research station at Khartoum and two small experimental farms close to the capital) (for 5 years, there has been no capital budget for renovating or maintaining buildings/labs, equipment, and vehicles);
- Its very limited national budget: LS 220 million (US\$ 0.14 million) in 1997, of which LS 170 million was for salaries paid directly by NCR and LS 50 million for operations (i.e., LS 2.6 million or around US\$ 1,640 per pRY);
- The absence of foreign/external scientific and financial support.

The Medicinal and Aromatic Plant Research Institute (MAPRI) - 15 graduate staff members allocate around 80% of their time to the research domains of the Institute, and represent some 12 pRYs.

The Remote Sensing Institute (RSI) - This Institute has 10 researchers, of whom 8 are involved in AR fields. As it was till recently an ENRRI department, it presents similar conditions.

### **Hydraulic Research Station of Gezira**

This Station, which was established by the Ministry of Irrigation in 1975, conducts research (100%) on irrigation scheduling, water requirements of the major crops, and salt and weed management in the Gezira Scheme. It has 5 researchers (2 PhD, 3 MS). Physical and financial resources are good because it has good linkages with IMMES. Linkages with ARC are informal (some joint research projects with ARC scientists). Prospects of merging with ARC are remote.

## **2.3 Faculties and Colleges of Agricultural Sciences (see Table 2)**

### **Overview**

As reported in Section 1, the national agricultural higher education system has dramatically evolved during the past few years. At present, it is rather complex and still changing; accordingly, a precise presentation of this system is a difficult task.

The 23 faculties and colleges of agricultural sciences (designated later as FASs) are semi-autonomous and are affiliated to different universities within MHESR: 5 are within the University of Khartoum (UK), 2 within the Sudan University of Science and Technology, Khartoum (SUST), 3 within the University of Gezira (UG), and 13 within other universities. They cover all the agricultural sciences, with a range of fields varying according to the FAS<sup>1</sup>.

Teaching is their main mandate; research and extension activities are generally limited (see below). All FASs provide undergraduate education; most of the oldest ones offer PhD and MS degrees; few still offer diploma education. Some of the oldest FASs have set up specialized centers for developing community services and research in specialized fields<sup>2</sup>.

### Human, Physical and Financial Resources

The 23 FASs (1997: see Table 2 and associated comments) comprise around 680 graduate academic staff members (including about 340 PhD, 200 MS and 140 BS holders, of whom 16% are females), who represent 170 potential RYs<sup>3</sup>. In general, the older ones have the largest and highest qualified academic staff (average of 59 staff members, with about 50% with PhD), and the newer ones are endowed with very limited permanent staff numbers (average of

<sup>1</sup> The Faculties of "agriculture" are involved in sciences related with crops, land, and water; the faculties of "veterinary science" are specialized in animal (production and health) sciences; the faculties of "agricultural sciences" or "agriculture and natural resources" cover all these scientific fields; the University of Khartoum (through its Marine Biological Laboratory of Suakin) and the Faculty of Oceanography and Fisheries of Elsharg University deal with oceanography.

<sup>2</sup> Such as the Faculty of Agriculture of UK which has a Central Analytical Lab, an Agricultural Service Center (which provides/sells services and inputs to surrounding farmers), and the recently established Desertification and Desert Cultivation Studies Center (with education and research which mobilize staff members of all the UK FASs). The Faculty of Agricultural Sciences of the UG has a Plant Pathology Center and has established in 1996 the Horticulture Export Crops Institute as an autonomous branch for postgraduate studies and research.

<sup>3</sup> Taking into account the normative rate of 25% of the academic staff members' time allocated to AR activities adopted for the analysis of all the WANA NARS (see methodology of the study).

17 staff members, 5 faculties have less than 10), and have to hire staff members from the older faculties and from AR institutes (ARC, ARRC).

Almost 75% of this staff is concentrated in Khartoum area (including the Faculty of Agriculture of Omdurman, and the FASs of Juba and Bahr El Ghazal Universities, temporarily located in Khartoum). Low salaries result in loss of talented staff and technicians.

Technicians and other support staff (laborers, clerks) are very few and are essentially involved in training activities (for example, FAUK has 0.23 technician/staff member, FASUG: 0.12).

Physical facilities in the Universities (buildings, libraries<sup>1</sup>, laboratory equipment, computer facilities, farmlands, machinery, vehicles, etc.) are generally inadequate in quantity and quality (poor maintenance, no replacement), except for the farms (every FAS has one or two farms for demonstration/training and for production). Electricity and water supplies are irregular or lacking.

The FASs' national financial resources (roughly estimated at LS 1,400 million) are essentially government-funded, with few limited self-earned sources. They are mainly allocated to salaries and wages (around 60–70% in the older FASs; more in the new ones). External grants are limited (LS 200 million) and mainly allocated to AR activities. Operational/capital budgets are generally poor: they amount to LS 1 million or US\$ 630 per staff member (average), with a maximum of LS 1.5 million per staff member in the best endowed FASs. Lengthy administrative procedures hamper timely availability of supplies and materials.

#### Linkages with Scientific Institutions

Linkages between "old" and "new" FASs relate to education activities, and are generally developed on an individual basis. Linkages to the national AR institutes and extension services are moderate and informal. External (regional and international) relations with scientific institutions and funding agencies are rather poor.

#### **Research in the Faculties** (Taher/Hamdoun, 1996)

In general, University AR suffers from a number of major constraints and limitations, namely:

- Lack of research policy of the FASs;
- Promotion criteria for the staff members, too heavily based on their degrees (MS, PhD);
- Heavy teaching loads<sup>2</sup>, which limit the staff members' availability for other activities;
- Inadequate research resources, reflecting the resource limitations presented above (lack of skilled technicians; poor physical facilities; decreasing, very limited and variable national and external funds for research);
- The weakness of the linkages with the national AR institutes.

Accordingly:

- AR is currently carried out mainly by young staff members and graduate students (with very limited direct involvement of the senior staff members);
- The actual percentage of human and financial resources allocated to AR activities is very low. The oldest FASs (affiliated to UK and UG) claim that their staff members dedicate 20–25% of their time to AR; however, their actual AR activities do not exceed 10% as reported in surveys done in 1995 and 1997. The other FASs (especially the 11 FASs established during the last 6 years) hardly conduct any AR at present;
- When research projects are implemented, their objectives are largely identified and chosen on a personal-interest basis and rarely according to the priority needs of the agricultural sector.

#### **2.4 The Other Institutions of the NARS** (see Table 3)

Most of the other institutions of the NARS are **scientific institutions**, namely:

<sup>1</sup> Only the library of the UK Faculty of Agriculture is relatively adequate, but is not equipped for taking full advantage of international data banks and information communication networks.

<sup>2</sup> In 1995, the number of students enrolled in the FASs was 9619 (49% of whom were females), which meant a ratio of students to teachers of 12:1; this ratio was 16:1 in the six FASs surveyed by Taher/Hamdoun (FAO, 1996). The current worst ratio is observed in FASUG (40:1 in 1998).

- The NCR Economic and Social Research Institute: This Institute, created in 1970, has 10 full-time researchers involved in research on the national policy and carry out studies that take into account the agricultural sector (which represents 40% of the GDP and employs 72% of the population), who roughly count for 5 pRYs;

- Some other university units: Most of the Faculties of Sciences and Economics of the Universities and some specialized units include staff members highly qualified in AR-related scientific fields (natural resources, plant and animal biology, agricultural engineering, food processing, rural social sciences), among which there are:

- The Department of Agricultural Engineering of the UK Faculty of Engineering, which has 10 academic staff members (3 PhD, 2 MS, 5 BS);
- The Institute of Environmental Study (IES) of UK: it offers postgraduate education on agricultural/rural, urban and industrial environmental issues; it has only 5 permanent scientific staff (3 PhD, 2 MS), but is supported by a rather large number of scientists (almost all are from UK). AR activities are mainly conducted as part of the PhD/MS thesis.

A precise inventory of the scientific potential concerned is not available, but according to a rough survey, it may total at least 40 academic staff members, who should represent 10 pRYs.

Within the category of other institutions there are also “**other non-scientific NARS institutions**,” among which is the Research Section of the Kenana Sugarcane Company. This unit has 13 researchers (5 PhD, 5 MS, 3 BS) specialized in breeding, agronomy, weed control, entomology, pathology and chemistry; it possesses good physical and financial resources, and maintains good complementary relations with the ARC sugarcane research station, also located at Kenana (5 researchers).

### 3. AR RESOURCES

#### 3.1 Human Resources (see Table 1)

The NARS involves more than 1,300 graduate scientific and technical staff members, all nationals, who represent 590 pRYs. The AR institutes gather around 44% of this staff who have an academic education (26% with PhD, 54% with MS). This is lower than in the FASs (around 50% with PhD and 40% with MS), which have been meeting the large majority of the highest qualified staff of the NARS (66% of the PhD holders).

The graduate scientists of the NARS are highly concentrated in/around Khartoum and the Gezira (more than 50 and 20% of the total, respectively).

A brain drain of qualified scientists (15–20%) to outside the NARS (the private sector and NGOs or abroad) was quite evident in the last 20 years. It was attributed to the deterioration of the salaries (reduction by around 30–40% in actual terms over the last decade because of the national economic crisis and the devaluation of the LS) and their poor level (currently LS 200,000 or US\$ 130 per month for a PhD holder; US\$ 80 and 50 for MS and BS holders)<sup>1</sup>.

ARC is the only NARS institution which employs a relatively good number of technicians (2 per researcher); most of the other institutions suffer a more severe deficit (ARRC: 0.13 per researcher; ENRRI: 0.6; FASs: 0.1; against the “norms” of 2–3 technicians per researcher in AR institutes). Qualified technicians are very much underpaid (US\$ 30/month), and opportunities for upgrading their education are limited. A similar situation is observed for the other support staff (laborers, clerks).

#### 3.2 Physical Resources

The NARS is endowed with a large network of research stations and farms, which covers most of the agroecological zones. With a few exceptions (part of ARC; Hydraulic Research Station of Gezira; Research Section of the Kenana Sugarcane Company), the other physical resources (offices; farm buildings; laboratories; and scientific, computer, transport, and communication equipment) are insufficient and poorly maintained.

The central library of ARC and that of the UK Faculty of Agriculture are satisfactory. However, most of the other NARS units and institutions lack documentation facilities.

<sup>1</sup> These salaries are much above the average annual per capita income in the country which amounted (1995) to US\$ 260 (according to the official exchange rate) and US\$ 1,100 in terms of “parity revenue” estimated by the World Bank (according to the cost of life). In addition to their salaries, most of the scientists are provided with either housing or housing allowance and often with transport; FAS scientists receive other incentives coming from extra academic load/teaching and supervision of postgraduate students.



### 3.3 Financial Resources (see Table 1)

The national AR financial resources have been decreasing over the last years. In 1997, total funding (national and external) reached around LS 4,970 million (US\$ 3.1 million), of which 4,560 million (US\$ 2.9 million) came from national sources (the Ministry of Treasury and institutions' self-earned resources), and LS 410 million (US\$ 0.2 million) from external funds essentially secured through bilateral or multilateral grants provided by few donors. The NARS national and total resources represent around 0.09 and 0.10%, respectively, of the agricultural gross domestic product (AGDP, estimated at US\$ 3.1 billion in 1996). Such ratios are among the lowest in developing countries.

In all institutions, delays in fund liquidation are frequent, the budget is unstable, and may be reduced during the growing season. Areas of expenditure vary considerably between the institutions: salaries and allowances represent 37% of the national budget of ARC, around 50% at ARRC, and much more in the other scientific institutions (ENRRI, FASs). The funds allocated to operating and capital costs (OCC) are highly variable and range from LS 7.1 million (US\$ 4,470) per pRY at ARC, LS 3.6 million at ARRC, LS 2.6 million at ENRRI, and LS 1 million per academic staff member in the FASs. The total OCC for the NARS amounts (approximately) to LS 2,300 million (US\$ 1.45 million), i.e., less than LS 3.9 million (US\$ 2,500) per pRY, which is very low and much under the "optimal" amount of US\$ 25,000–30,000 per RY used in the long-term plans elaborated by many countries in similar agroecological conditions. According to this norm, the NARS should have between 49 and 59 actual RYs (aRYs), as opposed to 590 pRYs, which means that actually the AR scientific potential is very poorly mobilized. The number of aRYs should be slightly higher (around 60–70 aRYs) because of the recent investments in ARC (during the period 1990–95), but the deterioration of capital is expected to lead to a worse situation (and less aRY) in the near future.

## 4. RESEARCH ACTIVITIES

### 4.1 Research Orientation

There is a clear division of research mandates between the two major institutes (ARC and ARRC), but their lack of coordination with the other NARS institutions which cover similar fields (ENRRI, FASs, etc.) and the absence of a national body actually responsible for the national AR policy create overlapping in the research mandates and waste of resources and facilities.

The research agendas of most of the AR institutes aim, to a large extent, to develop technically feasible, economically viable, socially acceptable and environmentally favorable technologies. Research programs of ARC and ARRC consist of an appropriate mix of laboratory, on-station, and on-farm research. At ARC, participation of target groups, researchers and management is advocated in the research programs and priority setting; programs are formulated to achieve operational research objectives and overcome challenges facing agricultural production. However, in the AR institutes, collaborative, multidisciplinary research directed towards farming systems and socioeconomic research is still not developed enough; in only few research projects, execution encompasses active involvement of researchers, extension workers and farmers to validate research results and assess new technologies.

At ENRRI and the universities, the research agendas are generally developed regardless of resource optimization and environmental concerns in the production system. Their programs have limited emphasis on validation of on-farm research under farmers' conditions, and the technologies generated and transferred are in most cases irrelevant to resource-poor farmers, resulting in inefficient technology transfer and poor adoption rate.

### 4.2 National and International Linkages

#### National Linkages

Linkages between research leaders and high-level decision-makers are witnessed in the reciprocal representation at each other's governing bodies, technical committees, and faculty boards. Linkages between the AR institutes and the FASs are informal and concentrated in the involvement of a large number of researchers in teaching undergraduate and postgraduate courses and supervising MS and PhD programs; however, very few collaborative research programs are conducted. ARC and ARRC participate in the discussion and execution of NGO and private sector research.

ARC and ARRC have developed reasonable linkages with national development agencies, extension services, and farmers through their involvement in on-farm research, demonstration plots, field days, feasibility studies, production of seeds and vaccine, soil/water/feed analysis, and training of extensionists, field inspectors, and farmers. Moreover, they publish extension leaflets and provide information on technologies in mass media, workshops, seminars, and conferences. ENRRI and the FASs play a limited role in this respect. However, the impact of research on agricultural development is rather limited because of the very high concentration of scientists at/around Khartoum and the Gezira, the shortage of

funds, and lack of mobility; and also of the weakness of the extension services (endowed with poor human, physical and financial resources) and farmers' organizations.

### International Linkages

In general, external cooperation is currently much less developed than in the past decades. Most of the NARS institutions are not receiving any scientific and financial international support. ARC has succeeded in preserving rather good linkages with some international AR centers, regional organizations, and donors (ICARDA, ICRISAT, AOAD, ASARECA, etc).

## 5. CONCLUSION

The strength of the Sudanese NARS arises from its high number of well-trained scientists and technical support staff, reasonable infrastructure and research facilities, and wide coverage of its AR activities over the major agroecological zones. ARC and ARRC are also seen as vital investment of public and private funds that warrants political support and long-term stability of funds at levels corresponding with their mandates and mission, as well as with national development objectives.

However, the NARS is largely underutilized by the acute shortage of funds, which has led to the decline and underemployment of human resources, the erosion of the infrastructure, and the poor effectiveness of research execution, especially in the FASs which are not able to carry out the research components of their mandates and mission.

Opportunities for greater efficiency, sustainability and impact can be achieved through allocation of adequate and sustainable funding for modernization and maintenance of equipment and research facilities and training postgraduates. Efforts to achieve this are in progress through the commercialization of some of the research outcomes, e.g., breeder and foundation seeds, food processing technologies, vaccine production, research contracts, utilization of research farms, and funding research programs by production corporations, commercial companies, and farmer associations. Promotion of formal linkages between components of the NARS at all levels are also under way to ensure maximum utilization of the available resources. Efforts to form a coordinating body encompassing all research institutions have been initiated.

### Main Acronyms

**MAF:** Ministry of Agriculture and Forestry. **MAR:** Ministry of Animal Resources. **MHESR:** Ministry of Higher Education and Scientific Research. **MI:** Ministry of Irrigation.

**AHE:** Agricultural higher education. **ARC:** Agricultural Research Corporation. **ARRC:** Animal Resources Research Corporation. **ENRRI:** Environment and Natural Resources Research Institute. **FASs:** Faculties of Agricultural Sciences. **NCR:** National Center for Research. **UG:** University of Gezira. **UK:** University of Khartoum. **VRLA:** Veterinary Research Laboratories Administration.

**LS:** Sudanese pound.

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**Table 1 - The National Agricultural Research System (1997/98)**
*Indices:* Approximate data, ... Data not available. \* See footnotes.

No.	NARS Institutions			AR Scientific & Techn. Graduate Staff* (Units)		Potential Res. Years*	Total Budget (million LS)		AR Expenditures/R.sources (E)			
	Name – Acronym (Head Office - Year Established)	Mandates AR Fields	Govern. Ministry	Total (PhD, MS)	Nat.		Ext.	Nat. E NE	For. E FE	Total E TE		
a	b	c	d	e	f	g	h	i	j	k	l	
2.1	Agricultural Research Corporation Wad Medani	ARC 1902, 67	AR 70% - (AD) All ext. livestock, fish	MAF	303	97, 126	212	3,300	300	2,800	260	3,060
2.2	Animal Resources Research Corporation Khartoum	ARRC 1903, 96	AR 65% - (AD) Liv., fish, wildlife	MAR	225	50, 155	146	2,000	0	1,100		1,100
2.3	NCR - 3 Research Institutes mainly involved in AR-related sciences, Khartoum *	ENRRI (92)	AR 60% - (AD) All	MHESR	32	3, 20	19	220	0	180	0	
		MAPRI (70)	AR 80% - (R/AD)		15	2, 10	12	80	0	70	0	290
		RSI (96)	AR 80% - R		8	1, 5	6	50	0	40	0	
2.4	Hydraulic Research Station, Gezira	1975	AR 100% - Irrig.	MI	5	2, 3	5	100	...	100	...	100
1/2	Total AR Institutes				588	153, 316	400	5,750	300	4,290	260	4,550
3	Total 23 Faculties/Colleges of Ag. Sciences (see Table 2)	1938-1996	AHE - (AR) All	MHESR	180	340, 200	170	1,400	200	150	150	300
4	Other NARS Institutions (see Section 2.4 and Table 3)			MHESR, ...	63	23, 21	25	...	...	120	...	120
5	Total NARS				1331	516, 537	595	...	...	4,560	410	4,970
Exchange Rates: LS 1,000 = US\$ 0.63 or US\$ 1 = LS 1,590 (1997 average official rate)					Actual Research Years (Estimate) (aRYs) →		60-70	AR Expend. (million US\$)		2.9	0.2	3.1

MAF: Ministry of Agriculture and Forestry. MAR: Ministry of Animal Resources. MHESR: Ministry of Higher Education and Scientific Research. MI: Ministry of Irrigation. NCR: National Center for Research. 23 ENRRI: Environment and Natural Resources Research Institute. MAPRI: Research Institute Medicinal and Aromatic Plant Research Institute. RSI: Remote Sensing Institute (8 AR researchers out of the 10 researchers).

e: Mandates: AR (%): Approximate average % of human resources devoted to ag. research (AR); R: Research; AHE: Ag. higher education; AD: Ag. development/services (for AR and AHE institute seed production, soil and water analysis, extension, studies, etc.). h, j: potential research-year (pRY) = equivalent full-time researcher; for the FASs, the pRYs were estimated by multiplying the number of academic staff by 0.25 for AR institutes. AR financial resources have been roughly estimated through the following formula: Total budget  $\times$  [(a  $\times$  0.5/(100 - a))], where a is the % of time devoted to AR by the graduate staff.

\* Note: All the graduate staff members are national.

National AR expenditures (NE): 0.09% of the Agricultural Gross Domestic Product (AGDP: US\$ 3.1 billion in 1996). Total AR expenditures (TE): 0.10% of the AGDP.

**Table 2 - The Faculties and Colleges of "Agricultural Sciences" (1997/98)**
*Italics:* Approximate data.

...: Data not available.

\*: See footnotes.

No.	University	The Agricultural Sciences Faculties		Mandate	Staff Members (All Nationals)	
		Name (Head Office - Year Established)			Total	PhD, MS
1	Khartoum (UK)	Fac. of Agriculture (FAUK), Khartoum/Shambat	1938	BS-MS-PhD	111	77, 16
2		Fac. of Forestry, Khartoum/Shambat	1975	BS-MS-PhD	15	12, 3
3		Fac. of Animal Production, Khartoum/Shambat	1983	BS-MS-PhD	25	14, 5
4		Fac. of Veterinary Sciences (FVSUK), Khartoum/Shambat	1938	BS-MS-PhD	93	52, 19
5		Suakin Marine Biological Laboratory, Suakin	19...	MS-PhD	...	...
6	Sudan Univ.	Col. of Agricultural Studies, Khartoum/Shambat	1954	Diploma-BS	48	18, 20
7	Khart. (SUST)	Fac. of Animal Production, Khartoum/Shambat	1984	BS-MS-PhD	...	...
8	Gezira (UG)	Fac. of Agricultural Sciences, Wad Medani	1978	BS-MS-PhD	80	35, 25
9		Abu Haraz Fac. of Ag. & Natur. Resour., Wad Medani	1978	Diploma-BS	26	6, 20
10	Juba	Fac. of Natur. Resou. & Environ. Studies, Khartoum*	1977	BS-MS-PhD	75*	24, 28
<b>Total "Old FASs"</b>					<b>474</b>	<b>238, 136</b>
11	Khartoum (UK)	Fac. of Agriculture, Azhari University, Khartoum	1996	BS - ...	...	...
12	Bahr El Ghazal	Fac. of Veterinary Sciences, Khartoum*	-	BS	11	...
13	Omdurman	Fac. of Agriculture, Omdurman (Khartoum)	1994	BS	10	...
14	Wadi-Nil	Col. of Agriculture, Dongola	1993	Diploma-BS	24	...
15	Gezira (UG)	Col. of Animal Production, Managil	1993	BS	5	1, 4
16	Sennar	Fac. of Agriculture, Abu Naama	1957 - 1994	BS	28	...
17		Fac. of Agriculture & Natur. Resour., Sennar	-	BS	7	...
18	Kassala	Fac. of Agriculture & Natur. Resour., New Halfa	-	BS	13	...
19	Kordofan	Fac. of Agriculture & Natur. Resour., El-Obed	1990	BS	28	...
20	El-Fasher	Fac. of Agriculture, El Fasher	-	BS	9	...
21		Fac. of Agriculture & Natur. Resour., Zalengi	1994	Diploma-BS	1	...
22	Nyala	Fac. of Veterinary Sciences, Nyala	-	BS	8	...
23	Elsharq	Fac. of Oceanography and Fisheries	-	BS - ...	...	...
<b>Total "New" FASs</b>					<b>144</b>	<b>...</b>
<b>Total A + B</b>					<b>618</b>	<b>...</b>

Source: Data provided by the FASs (1998), El Taher/Hamdoun, FAO (lines 3, 9, 10), and Casas (1998).

\*: 10 and 12: These 2 faculties are temporarily located in Khartoum.

Rough estimate of the number/qualification of the academic staff members of all the FASs: Around 680 members adding an estimated 40 members for the old FASs no. 5 and 7, and around 30 members for the new ones no. 11 and 23; with around 50% with PhD, 40% with MS and 10% with BS. These percentages are based on those observed in the "old faculties" since they are the most reliable and thus could be used as a basis for calculation in the "new faculties."

**Table 3 - Other Institutions of the NARS (1998)**
*Italics:* Approximate data.

...: Data not available.

\*: See footnotes.

No.	Other NARS Institutions			Scientific & Technical Senior Staff (Units)		
	Name (Head Office - Year Established)		Mandates	Total	PhD, MS	AR pRYs*
1	Economic and Social Research Institute, NCR, Khartoum	1970	R (AR)	10	2, 5	5
2	Depart. of Ag. Engineering/Fac of Engineering, U. Khartoum	1981	HE (R-AR)	10	3, 2	10
3	Institute of Environmental Study, U. Khartoum	1979	HE (R-AR)	5	3, 2	
4	Other University Institutions (see Section 2.4)		HE (R-AR)	25	10, 7*	
<b>Other NARS Scientific Institutions</b>				<b>50</b>	<b>18, 16</b>	<b>15</b>
B	Research Section of the Kenana Sugarcane Company, Kenana	...	AD (AR)	13	5, 5	10
<b>Total A + B</b>				<b>63</b>	<b>23, 21</b>	<b>25</b>

\*AR pRYs: potential RYs involved in agricultural research.

4: Estimation is based on considering these institutions to have the same % of PhD and MS holders as the university institutions no. 2 and 3.

## **6. MONOGRAPHS OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEMS OF WEST ASIA**

**CYPRUS**

**IRAQ**

*JORDAN*

**LEBANON**

**SYRIA**



## THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF CYPRUS<sup>1</sup>

There is only one institution in the NARS of Cyprus that carries out agricultural research (AR): the Agricultural Research Institute (ARI), it is presented in this monograph.

### 1. ORGANIZATION AND RESOURCES

ARI is organized in six sections (field crops, horticulture, plant protection, soils and water use, animal production and agricultural economics), and has a central chemistry laboratory providing analytical backup services, and also pursuing work on pesticide residue analysis. Two new sections are being established: biotechnology, and information and statistics.

At present, ARI employs 40 scientists, 67 technicians and a permanent labor force of 70 persons. ARI has given great emphasis to training its scientific staff to the highest possible level; as a result, all scientific staff received PhD or MS training in universities all over the world (22 PhD, 18 MS). The scientists are specialized in different disciplines, as this Institute covers all agricultural activities. In some cases, only one specialist covers the activities of related disciplines, because of the lack of staff. Most of the technicians (graduates of secondary schools) have also received short training (3–12 months) in foreign institutions.

ARI has an experimental farm near its headquarters and three farms in areas where specific crops are grown, but most of its work is carried out in farmers' fields. ARI has a library with the necessary books. It also subscribes to a limited number of scientific journals, but has access to abstracts of all major scientific journals.

The budget of ARI is prepared by the Director, in consultation with the heads of the sections, and is approved by the Council of Ministers and subsequently submitted to the Parliament for approval. The 1996 annual budget of ARI amounted to 2.7 million Cypriot pounds (£) (around US\$ 5.4 million), provided by the Government, with only £ 25,000 (US\$ 50,000) from other sources, mainly international agricultural research agencies and other donors. ARI's national budget amounted to around 0.54% of the Agricultural Gross Domestic Product (AGDP estimated at £ 0.5 billion or US\$ 1 billion in 1996).

### 2. RESEARCH POLICY AND PRIORITIES

#### 2.1 Research Policy

The policies on AR are formulated by the Council of Ministers, based on the suggestion of the Ministry of Agriculture, Natural Resources and Environment (MANRE). The Minister acts on the suggestions made by the Director of ARI and the Permanent Secretary of the Ministry. The views of the scientists of the Department of Agriculture (Extension and Development Programs) are taken into consideration in preparing research policies through contacts among leading scientists and the Directors of the two Programs.

The opinion of farmers in formulating AR policies is taken into consideration through direct contacts with research scientists, through the Extension Program of the Department of Agriculture, and through farmers' unions.

#### 2.2 Research Priorities

ARI undertakes applied and adaptive research on a wide range of activities in plant and livestock production. The main priorities are to use the limited natural resources efficiently and to promote cash crops for export. In the rainfed areas, the aim is to increase production through genetic improvement of crops and improved management by better utilization of the available water from the limited rainfall. Crops in this category include annuals (cereals, dryland food legumes, forage crops) and trees (almonds, olives, wine grapes, etc.). Efficient use of the limited irrigation water is a priority for cash crops and crops for export (citrus, potatoes, table grapes, etc.).

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<sup>1</sup> By Dr Andreas Hadjichristodoulou, Director (1997), Agricultural Research Institute.



Sustainability of natural resources and their protection from pollution receive high priority in all research programs. The efficient use of treated effluent also receives high priority as it provides water for irrigation and also eliminates pollution by sewage or industrial wastewater.

In livestock production, emphasis is given to the use of local feeding stuffs and by-products for products consumed locally. Efficient feeding, management and selection of breeds are high priorities in this program. The possibility of growing new crops also receives special attention. Aromatic and medicinal plants, requiring limited amounts of water for irrigation, are among the new activities of ARI. There is high demand in the world market at relatively high prices for products of aromatic plants.

Major research programs are: breeding of cereals and food legumes for dry lands, forage and pasture crops, agronomic practices and mechanization of field crops, tropical and subtropical fruit trees, deciduous fruit trees, viticulture, protected cultivation of vegetables, floriculture, plant genetic resources, entomology, plant pathology, weed control, soil fertility, water use and irrigation, use of sewage wastewater for irrigation, animal nutrition and management, animal breeding, agro-economic studies, and pesticide residues.

### 3. LINKAGES

The linkages of research leaders with high-level decision makers follows government procedures through proper channels, which are established as follows: research scientists - Head of Section - Director of the Institute - Permanent Secretary and Minister of MANRE - Minister of Finance - Council of Ministers and Parliament.

Normally, most of the decisions on AR are taken at the level of the Director of the Institute and MANRE. Access of research scientists and research leaders to the Director of the Institute is easy and frequent.

As ARI is the only NARS institution, links exist between Heads of Sections, dealing with research on different disciplines of crop and livestock production. These links are strong because all the sections operate under the same roof and under the same Director.

Development agencies and extension services on agriculture belong to MANRE. Most of these activities are under the Department of Agriculture.

Coordination of the activities of ARI and the Department of Agriculture is done through the Permanent Secretary of MANRE, where the two programs (development and extension) belong. Linkages of ARI with farmers exist either directly between researchers, leaders and the Director with farmers and their unions, or through the extension services of the Department of Agriculture.

Through these two channels the ideas of farmers and extension services are considered in identifying problems for research and the results are promoted for application. As most of the trials are done in farmers' fields, the farmer participates and is aware of the progress at the same time as the researcher.

Linkages of ARI with external sources of knowledge are strong; researchers have developed strong links with universities and institutions in other countries, known to be leaders on specific projects.

Results and plant material (seeds, etc.) of improved crops developed by ARI are provided freely to all interested individuals and institutions.

ARI cooperates closely with International Centers of the CGIAR systems (ICARDA, CIMMYT, IPGRI, CIAT, IITA, etc.) and FAO. It also participates in many European or Near East and North Africa regional projects operated by the International Centers.

### 4. SYNOPSIS OF ARI'S PRESENT AND FUTURE

ARI, being the only institution on AR in a small country, has certain advantages, but it also faces some constraints connected with this situation.

ARI, which was established soon after independence of Cyprus after 80 years of British rule, was staffed by enthusiastic and devoted young scientists and was organized in an efficient way with the help of FAO. Many of these scientists are still working at the Institute; some have already retired. Especially during the first years, the Government gave great support to ARI, as agriculture was one of the strongest sectors of the economy. Furthermore, training opportunities were good and most of the staff received the highest available training. Technical staff also received training in foreign countries. As a result of all these positive achievements, the young Institute has not shown any signs of inexperience. During its first 30 years of life, it has managed to be respected by local people for

the solutions provided to major agricultural problems and by foreign scientists for the high level of scientific research work published frequently in international scientific journals.

Naturally, the majority of the staff employed during the first decade of the life of ARI reached retirement age, which is 60 years. Furthermore, most of the experienced staff will retire by the year 2005. At present, the relative importance of the agricultural sector in the GNP is much smaller than it was in the 1960s, and the Government does not allow the recruitment of new staff, even after the retirement of old staff. This will create a shortage of trained scientific and technical staff. In exceptional cases only, new staff has been employed recently.

The future of ARI lies in its capacity to restructure its organization and research programs to face present and future challenges. Some research programs, initiated in the 1960s, have accomplished their targets; in some cases, almost completely. Thus, activities in these areas should be reduced drastically and research activities initiated in other areas, creating more significant gains for the agricultural sector of the economy. Very limited work on new crops, like aromatic and medicinal plants, is under way. Contrary to presently grown crops, which are supported by subsidies, aromatics command high prices in the world market and thus require no substantial government support.

The Director and the staff of ARI, realizing the need for change, are already taking the necessary steps in the formulation of the correct research plans which would retain or even improve the role of ARI in the coming 30–50 years.

ARI's capacity, as mentioned above, is rated very high, but its future depends on recruitment and training of new staff. Inter-institutional comparison is not applicable in Cyprus, as there is only one institute carrying out AR.

### **Main Acronyms**

**ARI:** Agricultural Research Institute. **MANRE:** Ministry of Agriculture, Natural Resources and Environment.

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF IRAQ<sup>1</sup>

## 1. HISTORICAL BACKGROUND

In the 1920s, a Directorate General of Agriculture, affiliated to the Ministry of Economics and Transport, started agricultural research (AR) activities and established the first experimental stations at Abu Ghraib and Neinevah, and the Central Veterinary Laboratory, which focused its work on the diagnosis and control of pests and animal diseases.

In the 1940s, AR activities were covered by the Directorate General for Agricultural Research and Extension (DGARE) of the Ministry of Agriculture (MOA), with its headquarters at Abu Ghraib. They were further strengthened upon the establishment of the College of Agriculture (created in 1952 by MOA) and the College of Veterinary Medicine (1956), affiliated to the University of Baghdad.

In 1958, the Directorate General for Agricultural Research and Projects (DGAREJ) was established as the only body responsible for AR within MOA, except for the research on forestry assigned to the State Board of Forestry. In 1968, DGAREJ was terminated and AR came under the responsibility of four directorates concerned with agronomy, horticulture, animal resources, and plant protection and agricultural extension. During the 1970s, research activities were expanded as MOA established several specialized research stations and centers in different parts of the country.

This period also witnessed the establishment of the College of Agriculture and the College of Veterinary Medicine at Mosul University in 1964 and 1968, respectively, the College of Agriculture of Basrah in 1973, and the Iraqi Atomic Energy Commission (IAEC) in 1967, endowed with an Agricultural and Biological Research Center (later restructured into four specialized centers).

In 1980, MOA established the State Board for Applied Agricultural Research (SBAAR) to be responsible for all its AR activities. With the merging of MOA and the Ministry of Irrigation (MOI) in 1987, SBAAR integrated the Center for Water and Soil Resources (CWSR) and was renamed as the State Board for Agricultural Research and Water Resources (SBARWS). In 1990, SBARWS was terminated and replaced by the State Board for Agricultural Research (SBAR) and CWSR. When MOA and MOI separated again in 1993, SBAR remained within MOA and CWSR went to MOI.

Two Colleges of Agriculture were founded at Tikrit and Anbar in 1993 and 1994, respectively, and one College of Veterinary Medicine at Qadisia University in 1994.

## 2. THE CURRENT NARS

### 2.1 Overview (see Table 1)

The Iraqi NARS is currently (1997) made up of three main categories of institutions:

- The institutions specialized mainly in AR: the State Board for Agricultural Research (SBAR), affiliated to MOA, and the Center for Water and Soil Research (CWSR) of the Ministry of Irrigation, which account together for 32% of the potential research years (pRYs: equivalent full-time researchers) of the NARS<sup>2</sup>; they are presented in Section 2.2.
- Five colleges of agriculture and three colleges of veterinary medicine supervised by the Ministry of Higher Education and Scientific Research (MHESR), which gather 49% of the pRYs of the NARS (see Section 2.3).
- Other scientific and technical institutions for which AR is a secondary mandate (mainly the four AR-related centers of the Iraqi Atomic Energy Commission), which account for 19% of the pRYs (see Section 2.4).

Officially, MOA has the responsibility of the national AR policy, but in practice it shares it with other institutions and ministries involved in AR activities.

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<sup>1</sup> By **Dr Basil K. Dalaly**, First Under Secretary, Ministry of Agriculture; **Dr Raad M. Salman**, Head of Botany Department; and **Dr Kahtan A. Al-Azzawi**, DG in the Ministry of Agriculture.

<sup>2</sup> **Table 1** do not provide any data on the financial resources of the NARS, which are usually considered major information or criteria for assessing the relative importance of the NARS institutions and their actual capacity for mobilizing their human and physical resources.

## **2.2 The AR Institutions**

### **The State Board for Agricultural Research (SBAR)**

#### **Mandate and Organization**

SBAR is the largest NARS institution: it represents 26% of the potential RYs (pRYs)<sup>1</sup> of the NARS. Its main mandate is AR which mobilizes about 75% of the time of its professional staff. Other activities cover community services (soil analysis, seed production, etc.), extension and training.

At present, SBAR consists of six main agricultural divisions: agronomy, horticulture and forestry, date palms and tissue culture, soils, animal resources, and plant protection.

#### **Human, Physical and Financial Resources**

SBAR currently (1997) has 638 national permanent full-time staff, of whom 266 are professional graduate staff who represent around 200 pRYs. The academic level of the graduate staff is rather low (37 PhD, 54 MS, and 175 BS holders); this situation is the consequence of the salaries offered up to the end of 1995 by SBAR (and the MOA institutions), which were considerably lower than those paid to the university staff members. SBAR could not attract highly qualified researchers, and many researchers found their way to the universities; however, in 1995, salaries were increased in the range of 100-200%.

Technicians are not sufficient either in number or quality, because of low salaries offered and budget restrictions.

SBAR has 14 research stations which cover key agroecological zones (in irrigated and rainfed areas). Infrastructure and equipment (offices; labs; libraries; scientific, computer, transport and communication facilities), which were considered fair 10 years ago, are now suffering from lack of maintenance, replacement or modernization. The problem of spare parts replacement is very acute.

Financial resources are funded mostly by the country (essentially by the Government, with some self-earned income coming from sales of services/products and from research contracts funded by national development organizations). External grants are very few (see Section 4.2). Operational and capital costs, which may represent 35% of the available resources, are far from covering the needs, and the SBAR scientific potential is much underemployed.

#### **Research Activities and Linkages**

Research activities include both crop and animal production. Within crop production, priority is given to cereals (wheat, rice, barley, corn) as they represent the main crops for human consumption under the present circumstances and the sanctions imposed on Iraq. Attention is also given to industrial crops (cotton, sunflower) and horticultural crops. Research is also conducted on forestry, fisheries, agricultural economics, agricultural machinery, etc.

A new research policy has been adopted so as to improve relationships with development organizations (see Section 4.1). An executive committee was recently founded to periodically review research accomplishments and obstacles.

SBAR cooperates with CWSR through joint teams whenever necessary. Likewise, there is continuous cooperation between SBAR and the universities; its staff may deliver some lectures or take part in joint research programs. International scientific cooperation is very limited (see Section 4.2).

### **The Center for Water and Soil Research (CWSR)**

This Center employs a total of 58 professional graduate staff members (9 PhD, 9 MS, 40 BS). It has faced the same comparatively low salaries as SBAR. Numbers of technicians and other support staff are very insufficient.

erosion and sediment transportation, use of saline water in irrigation and land reclamation, efficiency of irrigation systems, drainage performance, water pollution, soil survey, and soil management.

## **2.3 The Colleges of Agriculture and Veterinary Medicine**

### **Overview**

The five colleges of agriculture and three colleges of veterinary medicine are supervised by their respective universities which are autonomous public institutions (each governed by a council of deans) supervised by the Ministry of Higher Education and Scientific Research (MHESR). These are:

- the College of Agriculture (CA), Baghdad University: It is the oldest CA, considered as the mother college of all agricultural institutes in Iraq, and the largest one, with 507 academic staff members (asm), including 188 PhD and 150 MS holders;
- the College of Agriculture and Forestry, Mosul University (267 asm, 107 PhD and 124 MS holders);
- the CAs of Basrah University (189 asm, 44 PhD and 79 MS holders), Tikrit University (51 asm, 18 PhD and 19 MS holders), and Anbar University (46 asm, 11 PhD and 23 MS holders); and
- the College of Veterinary Medicine (CVM), Baghdad University, the oldest and largest CVM (293 asm, 91 PhD and 104 MS holders); and the CVMs of Mosul University (127 asm, 31 PhD and 54 MS holders) and Qadisia University (30 asm, 3 PhD and 12 MS holders).

The eight colleges employ a total of 1510 academic staff members (including 493 PhD, 467 MS and 550 BS holders). Their main mandate is teaching: all colleges grant BS degrees, while those of Baghdad, Mosul, and Basrah grant MS and PhD degrees as well. There are about 11,000 students enrolled in the eight colleges, which means a reasonable number of students per academic staff member (an average of 7.3). Other mandates cover research (see below) and extension, but the time and effort spent by university staff on extension is rather limited. Some coordination exists among the CAs and CVMs through quarterly meetings of their deans.

### Research Activities

The CAs were founded in different regions of the country so as to solve the agricultural problems that may exist in these regions. For example, CA/Baghdad is mainly concerned with irrigated areas and horticulture; CAF/Mosul (northern part of Iraq) with cereal production in rainfed areas, forestry and wood technology; CA/Tikrit with gypseous soil cultivation; and CA/Basrah with date palm research, horticulture and fisheries. All CAs and CVMs are concerned with animal husbandry.

The CAs and CVMs have high comparative advantages for AR activities: they enjoy a very large number of qualified academic staff in all disciplines and fields; they are able to mobilize for research strong graduate study programs (243 and 296 students enrolled at the PhD and MS levels).

However, AR is constrained by several factors:

- Most of the support resources (technicians, buildings, labs, farms) are devoted to education; specific research resources are very limited (few technicians, inadequate labs and scientific equipment, few vehicles, poor libraries, low and unstable funds).
- The CAs and CVMs lack coherent research policies and research management systems.
- Relations with national AR institutes and with farmers and extension workers are limited. Due to the sanctions imposed on Iraq, contacts and communication with the outside world are very limited.

These factors have badly affected research activities. According to CA and CVM officials, academic staff members may allocate 2025% of their time for research and research-linked activities, which would represent about 380 potential RYs. This ratio has been actually much lower during the last years, and probably does not currently exceed 10%, which would represent only around 150 actual RYs for the eight colleges. However, since the adoption of the national strategy for agricultural research and transfer of technology in 1995 (see Section 4.1), the situation has slightly improved. Academic staff members of the colleges are becoming active participants in all the national development programs (cereals and legumes, cotton, corn, tomato, and rice) supervised by MOA. These activities strengthen university contacts with farmers and extension workers through research output that is formulated in extension material in collaboration with the MOA Directorate General of Agricultural Extension.

## 2.4 The Other Scientific and Technical Institutions of the NARS

### The Other Scientific Institutions of the NARS

They include the Iraqi Atomic Energy Commission and other units affiliated to universities.

The Iraqi Atomic Energy Commission (IAEC) - IAEC currently has four AR-related centers created recently from dividing its previous Agricultural and Biological Research Center; they are the Agricultural Research Center, the Fisheries Research Center, the Seed Technology Center, and the Biotechnology Center. These Centers may account for about a quarter of the IAEC total professional staff members (392, including 43 PhD, 84 MS, 265 BS holders), which gives around 100 researchers working full-time on agronomy, horticulture, livestock, fisheries, natural resources, seed technology, biotechnology and other different cross-sectoral fields.

University Units Specialized in Agriculture-Related Sciences - Apart from the agricultural colleges presented above, most universities have units specialized in agriculture-related sciences, such as breeding, pathology, entomology and microbiology in departments of plant/animal biology; soil and water in some faculties of sciences; food technology and agricultural mechanization in faculties of engineering; rural socioeconomics in faculties of economics; etc., with highly qualified academic staff members. Some universities or faculties have set up training/research departments or units to boost research in these domains; for example, the Department of Biotechnology and Genetic Engineering, Baghdad University<sup>1</sup>, and the Center of Environment Beach Research, Mustanserih University<sup>2</sup>. The agricultural divisions of the Polytechnic Institutes<sup>3</sup> also fall in this category of institutions.

No precise inventory of this scientific potential has been made recently; however, according to the partial information available the agricultural colleges, these scientists may represent about 50 potential RYs or 20 actual RYs.

### **The Other NARS Technical Institutions**

Some administrative units and public enterprises are or have been directly involved in AR through research development units (stations, labs) or informal permanent or temporary research activities, such as the General Directorate of Irrigation Projects and Land Reclamation, Baghdad<sup>4</sup>, and the General Organization for Food Industries (headquarters in Baghdad), mentioned in the 1991 ISESCO inventory on the Islamic research centers. No clear data is available on this category of institutions, their AR activities and resources; therefore, they are not included in the synthesis Table 1.

## **3. AR RESOURCES**

### **3.1 Human Resources**

The Iraqi NARS currently involves more than 2,100 scientific and technical graduate staff, all nationals, who represent 770 pRYs. The academic staff members of the agricultural colleges constitute the bulk of this potential, with a high academic level (33% are PhD holders). SBAR and CWSR researchers are much less in number and have a much lower academic level (only 14% are PhD holders).

In general, the number and quality of technicians and other support staff are insufficient and may represent a strong

### **3.2 Financial and Physical Resources**

Funding of research activities is mainly secured through government allocation for both public institutions and universities. Marginal funds come from self-earned sources such as research contracts with development organizations, consultancies to the private sector, and sales of agricultural production (seed, market production).

Under sanction conditions, a high proportion of the available funds is allocated to salaries in all NARS institutions. In other words, very limited resources are available for operational and capital expenses. It is also impossible to purchase foreign equipment (scientific facilities, vehicles, etc.), books, journal subscriptions, etc., and current international cooperation is too limited for compensating this gap.

Accordingly, the NARS physical resources are deteriorating, and the large human scientific potential built in the 1980s is currently very underemployed: the NARS has (rough estimate) only about 200 to 250 actual RYs (including about 100 to 150 aRYs for the AR institutes, 40 for the colleges, and 60 for the other institutions) against the 770 potential RYs mentioned above.

<sup>1</sup> This unit (formerly a research center called the Biological Scientific Research Center) has 31 scientists (including 10 PhD, 13 MS) involved in education at the graduate level (MS and PhD) and research in biotechnology, gene transfer, cloning and molecular biology genetics, applied mainly to agriculture (other areas are involved, such as pharmacy and medicine).

<sup>2</sup> This Center, established in 1995, has 8 scientists (3 PhD, 5 MS, with backgrounds in agriculture, biology, engineering) working on a part-time basis in research (activities just starting) and in consultancies to the Ministries of Health and Irrigation on environmental issues.

<sup>3</sup> Three Polytechnic Institutes (with 349 academic staff members, including 43 PhD and 84 MS holders) have agricultural divisions which grant an agricultural diploma after 2 years of academic orientation and training.

<sup>4</sup> This unit, formerly named the Organization for Land Reclamation (153 professional staff, including 1 PhD and 1 MS), now affiliated to MOI (with possible transfer to MOA in the near future), has a Department of Western Desert and Desertification Control which may have some research activities.

#### **4. RESEARCH ACTIVITIES**

##### **4.1 Research Policy and Orientation**

The national strategy for agricultural research and transfer of technology, adopted in 1995, aims to support the agricultural policy which focuses on achieving: (i) food self-sufficiency through (mainly) adoption of new, more productive technologies; (ii) sustainability of agricultural production on the long-run by insuring sound management and development of available agricultural resources, especially land and water; and (iii) social and economic equity between the agricultural sector and other sectors of the economy, and within the agricultural sector itself. This strategy is an important achievement for the NARS, especially for SBAR and IAEC. According to the strategy:

- Research programs should be mainly applied and/or adaptive in nature. They should (i) be multidisciplinary in their approach and represent a continuum starting from the generation of technologies through on-farm trials and demonstrations and the transfer of results to potential users; (ii) include socioeconomic components to ensure the economic soundness and acceptance of research outputs and recommendations by the potential users; and (iii) be oriented towards developing and adopting technologies, management practices and policies which address the problems and needs of the agricultural sector. Research programs should give emphasis to the production system dimension consisting of four major thrusts: irrigated agriculture, rainfed agriculture (above 450 mm), low rainfed areas, and integrated livestock. The production systems are considered the umbrella under which the traditional commodity and non-commodity research programs operate.
- The strategy mandates all NARS institutions with applied research and transfer of technology activities, and with the responsibility of coordinating and supporting national AR programs so that they can help in identification, testing, transfer and adoption of technical management and policy information contributing to the objectives of the national agricultural policy. Such mandates may have beneficial impact on research planning, priority setting and management of research programs, and will help the scientists to conduct their research on the farm level and to be in direct contact with the farmer.
- The strategy defines roles of the various institutions in order to achieve stronger interrelationships and complementarity among them, which is the only proper way to address national issues under the constraints of limited financial and human resources due to the sanctions imposed on Iraq.

##### **4.2 National and International Linkages**

Until recently, linkages between the NARS institutions and the different ministries concerned with AR were weak and consisted mainly of formal means, such as memberships in research councils and the participation of SBAR and IAEC members in committees of different research programs at the universities and vice versa. But there was a substantial gap in the working linkages: research activities were undertaken by each institution without consultation with the others working in similar areas, this resulted in duplication of efforts and waste of time and resources. Linkages of the NARS institutions with extension/development organizations and with farmers were also insufficient.

These linkages have improved with the implementation of the national strategy for agricultural research and transfer of technology. Collaboration between SBAR and the colleges of agriculture is becoming stronger through the participation of university staff in conducting joint research activities and through the holding of joint field days, seminars, and writing of joint publications. Relations with extension/development organizations and with farmers have grown through the national development programs. The researchers in general (and to a much lesser extent the academic staff members of the colleges) have also become extension workers through conducting adaptive research with the farmers on the farms and transferring their research results to the farmers.

Due to the sanction conditions, the Iraqi NARS has limited scientific international relations. The major current partners are ICARDA, ACSAD and FAO. Collaboration with ICARDA focuses on cereals, grain legumes, support services (documentation, computers), and multidisciplinary research/development programs (Mashreq/Maghreb Project, funded by IFAD) with a technology transfer dimension on line with the national strategy.

#### **5. CONCLUSION**

The Iraqi NARS is made up of two main categories of institutions which have opposite features: the AR institutes linked to the Ministries of Agriculture and Irrigation, and the agricultural colleges. In the AR institutes, the graduate research staff members have a relatively low academic level and are few in comparison with the large number of research activities to be carried out, but they enjoy the largest research facilities. The colleges have a large number of well-qualified academic staff, with limited research physical resources. For a long time, these two groups have maintained limited research collaboration and could not take advantage of their complementarity, which has led to a

rather large waste of the national resources involved in AR.

The sanctions imposed on Iraq in 1990 have worsened this situation: with low financial resources and no access to foreign goods, all the NARS institutions have been suffering from an increasing underemployment and erosion of their scientific potential as well as a deterioration of their physical facilities.

However, the high priority given to agricultural development and the national strategy for agricultural research and transfer of technology adopted in 1995 offer better perspectives for AR in the country, which should allow reinforcement of SBAR and CWSR, larger research involvement of the colleges, improved relations between these scientific institutions, and efficient linkages with development organizations.

#### Main Acronyms

**MOA:** Ministry of Agriculture. **MOI:** Ministry of Irrigation. **MHESR:** Ministry of Higher Education and Scientific Research.

**SBAR:** State Board for Agricultural Research. **CWSR:** Center for Water and Soil Research. **CA:** College of Agriculture. **CVM:** College of Veterinary Medicine.

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Table 1 - The National Agricultural Research System (1996/97)\*

Italics: Approximate data. \*: See footnotes.

NARS Institutions				AR Scientific & Technical Graduate Staff * (Units)		Potential Res. Years*	
No.	Name - Acronym Head Office - Year Established	Mandates AR Fields	Govern. Minist.	Total	(PhD , MS)		
a	b	c	d	e	f	g	
1.1	State Board for Agricultural Research, Baghdad SBAR - 1972-80	AR (75%) - All (exc. an. health, fish)	MOA	266	37 , 54	200	
2.1	Center of Water and Soil Research, Baghdad CWSR -1980-93	AR (75%) - (AD) - Water, soil	MOI	58	9 , 9	44	
1-2	Total Agricultural Research Institutes			324	46 , 63	244	
3.1	College of Agriculture, Anbar Univ. CA/A - 1994	AHE - (AR) - All	MHESR	46	11 , 23	12	
3.2	College of Agriculture, Baghdad Univ. CA/Bag - 1952	AHE - (AR) - All	MHESR	507	188 , 150	127	
3.3	College of Agriculture, Basrah Univ. CA/Bas - 1973	AHE - (AR) - All	MHESR	189	44 , 79	47	
3.4	College of Agriculture, Tikrit Univ. CA/T - 1993	AHE - (AR) - All	MHESR	51	18 , 19	13	
3.5	College of Agriculture & Forestry, Mosul Univ. CA/M - 1964	AHE - (AR) - All	MHESR	267	107 , 124	67	
3.6	College of Veterinary Medicine, Baghdad Univ. CV/Bag - 1956	AHE - (AR) - Anim. prod./health	MHESR	293	91 , 104	73	
3.7	College of Veterinary Medicine, Mosul Univ. CV/M - 1968	AHE - (AR) - Anim. prod./health	MHESR	127	31 , 54	32	
3.8	College of Veterinary Medicine, Qadisia Univ. CV/Q - 1994	AHE - (AR) - Anim. prod./health	MHESR	30	3 , 12	8	
3	Total Ag. Sciences Colleges			1510	493 , 467	376	
4.1	Ag. & Biol. Res. Centers, Iraqi Atomic EC, Baghdad 1967	AR (100%: Ag. biology)	IAEC	100	12 , 25	100	
4.2	AR related university units (see monograph)		AHE - (AR)	MHESR	200	70 , 60	50
4	Total Other Scientific Institutions			300	82 , 85	150	
5	Total NARS			2134	621 , 615	770	
Exchange Rate: 1 Iraqi Dinar = US\$ 3.13 (1996 official average rate)				Actual Research Years (aRYs) (Estimate) -->		200250	

MOA: Ministry of Agriculture, MOI Min. of Irrigation, MHESR Min. of Higher Education and Scientific Research, IAEC: Iraqi Atomic Energy Commission.

c: Mandates: AR (... %): Approximate average % of human resources devoted to ag. research (AR); R: Research; AHE: higher education; AD: Ag. development/services (for AR and AHE institutes: seed production, soil and water analysis, extension, studies, etc.); g: Potential research year (pRY) = equivalent full-time researcher; for the FAS, the pRYs have been estimated multiplying the number of academic staff by 0.25.

\* Notes: All the graduate staff members and RYs are national. Data on budgets and AR expenditures are not available.

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF JORDAN<sup>1</sup>

## 1. HISTORICAL BACKGROUND

The importance of **agricultural research** (AR) has been recognized early by the Government of Jordan. The first AR station was established in Deir Alla in the Jordan Valley in 1951 and was followed, in the 1950s, by several research stations in the various agroecological zones of the country.

Research programs were initially formulated and carried out by the various technical divisions of the Ministry of Agriculture (MOA): agronomy, horticulture, plant protection, and animal husbandry. In 1958, MOA established the Department of Scientific Agricultural Research, which became responsible for all research activities previously undertaken by the technical divisions of the Ministry.

In 1970, research and extension were merged into one department, the Department of Scientific Research and Agricultural Extension. In 1985, as a result of MOA restructuring, this department was replaced by the National Center for Agricultural Research and Technology Transfer (NCARTT), which later strongly benefited from the National Agricultural Development Project (NADP), funded by the Government of Jordan and USAID.

**Agricultural higher education** (AHE), with its AR-related activities, started in 1972 with the inception of the Faculty of Agriculture (FA) at the University of Jordan (UOJ), then with the foundation by UOJ in 1974 of the Marine Science Station (MSS) of Aqaba, and in 1982 of the Research Center for Water Studies, renamed as the Water and Environment Research and Study Center (WERSC) in 1992. Later, four other faculties of agricultural sciences were established: FA (1986) and Faculty of Veterinary Medicine (1990) at Jordan University of Science and Technology (JUST), FA at the private Jerash University (1993), and FA at Muta University (1994).

## 2. THE CURRENT NARS

### 2.1 Overview (see Table 1)

The Jordanian NARS is made up of two main sets of institutions:

- The scientific institutions which have AR as their central mandate: NCARTT, WERSC, and MSS. These institutions account together for around 67% of the potential research years (pRYs: equivalent full-time researchers) and 79% of the total financial resources of the NARS; they are presented in Section 2.2.
- The five faculties of agricultural sciences, which are more or less involved in AR, accounting for 25% of pRYs and 18% of the total financial resources of the NARS (see Section 2.3).

Few other scientific and technical institutions allocate some resources to AR (around 8% of the pRYs and 3% of the total financial resources of the NARS). These are briefly presented in Section 2.4.

NCARTT is responsible for coordinating all AR and technology transfer activities in Jordan. The Higher Council for Science and Technology (HCST), an autonomous institution established in 1983 and governed by a council chaired by the Crown Prince, is responsible for the national scientific policy, but has a marginal role in AR; it mainly funds AR activities carried out by various institutions of the NARS.

### 2.2 The AR Institutions

**The National Center for Agricultural Research and Technology Transfer (NCARTT)**

#### Mandate

NCARTT is the largest NARS institution (around 61% of the pRYs and 66% of the total financial resources of the NARS). It is an autonomous public institution governed by a council chaired by the Minister of Agriculture<sup>2</sup>.

<sup>1</sup> By **Dr Awni Taimeh**, Director General, NCARTT, and **Dr Sami Sunna**, Head, Middle East for Management of Agricultural Resources and Environment (Private Consulting Group, Amman). The authors wish to thank all those who have contributed directly or indirectly to the study, particularly the Deans of the Faculties of Agriculture at UOJ and JUST, the Dean of the Faculty of Science at Yarmouk University, and the Directors of WERSC and MSS at Aqaba.

<sup>2</sup> The membership consists of NCARTT Director General, Secretary General of the Higher Council of Science and Technology, MOA Secretary General, a representative of the Ministry of Planning, a representative of the Ministry of Water and Irrigation, a professor from each of the faculties of agriculture at the public universities, and an individual with experience in the field of scientific research, appointed by the Minister for a period of two years, extendible one time.

According to the Agricultural Policy Charter (November 1996), NCARTT has two main mandates. The major mandate is AR, which mobilizes around 70% of the time of the senior staff; NCARTT carries out applied and adaptive activities in all AR fields, alone or in collaboration with other scientific and technical organizations in and outside Jordan. The second mandate is technology transfer; NCARTT provides technical expertise and backstopping for extension institutions and departments in the form of technical support, publications and recommendations, as well as training for extension personnel, on-farm trials and demonstrations, and provides a mechanism for a regular two-way flow of information and feedback between researchers, extension agents and producers.

### Resources

NCARTT has currently (June 1998) around 595 national permanent full-time staff, of whom 173 are scientific and technical graduate staff, who represent around 121 pRYs<sup>1</sup>, and 29 technicians. The remaining is support staff (clerks, accountants, laborers, etc.).

The rather low qualification of the 173 graduate staff (16 PhD, 70 MS, 87 BS) can be explained by the large past difference of salaries from those of university staff (salaries of researchers with PhD could be as low as 50% of equivalent academic scientists). However, this situation is changing with the recent improvement (1996) of the -graduate training (17 and 18 are preparing MS and PhD degrees, respectively, at the University of Jordan, Amman).

The ratios of technicians and other support staff to researcher (0.16:1 and 2.3:1, respectively) are much under the general agreed upon standards (2 and 34, respectively); however, many BS holders are actually working as technicians.

The Center operates through:

- of the PhD holders) is concentrated, and includes the central offices, laboratories and library;
- 6 Regional Centers for Agricultural Research and Technology Transfer (RCARTT) located in the major agricultural regions of Jordan (Mushagar, Deir Alla, Rabba, Shoubak, Ramtha, Khaldiah), each endowed with a main building (offices, auditorium and laboratories), a farm-machinery unit, a transport unit and a large experimental farm; and
- 12 research stations associated with this network.

In general, research facilities (offices, labs, farms, equipment, vehicles, etc.), information services, and land resources (total: 12565 ha) are good.

NCARTT financial resources have considerably evolved during the past years. During the period 1987/1994, the Center benefited from large resources provided by the National Agricultural Development Project (NADP), funded by the Government and USAID, which allowed the physical development of its headquarters and regional centers<sup>2</sup>. After this period, resources largely decreased until 1996<sup>3</sup>. In 1997, they started to steadily improve reaching around Jordanian dinars (JD) 3.4 million (US\$ 4.85 million), of which JD 2.5 million came from national sources, JD 0.2 million from a new World Bank loan (US\$ 0.9 million for 4 years used for purchasing equipment and training), and JD 0.7 million from external grants (EU, UNDP, etc.); such resources (allocated almost equally between salaries and other costs) are considered sufficient for covering almost all the research needs of the researchers on duty. With the scheduled foreign grants, the financial prospects for the next years look rather excellent.

### Research Activities and Linkages

The main research thrusts cover irrigated agriculture (25 researchers), rainfed crops (51), animal production (9), natural resources (16), and technology transfer and economics (4); the remaining researchers are distributed among other units (plant genetic resources, integrated pest management, etc.). Compared with the breakdown proposed by the National Strategy for Agricultural Research and Technology Transfer formulated in 1996 (see Section 4.1), rainfed crops and natural resources appear to be slightly favored at the expense of animal production and technology transfer/economics.

<sup>1</sup> pRYs = Number of researchers on duty H70% (percentage of the senior staff time devoted to AR).

<sup>2</sup> At its launching, this Project aimed to develop agriculture in the highlands; later, it expanded to include the Jordan Valley. The scheduled amount of the Project was US\$ 62.3 million, including a USAID contribution of US\$ 27.5 million (consisting of grants of US\$ 20.5 million for facilities, operation, technical assistance, and a loan of US\$ 7 million for buildings) and a Government contribution of US\$ 30 million (for staffing, land, operational expenses). The national contribution was not fully provided; however, it steadily increased throughout the years (from US\$ 1.2 million in 1987 to 2 million in 1993) (see Leroy, 1991).

<sup>3</sup> In 1996, NCARTT resources amounted to JD 2.26 million (US\$ 3.19 million), coming mainly from the government budget (JD 2.19 million), with very limited external grants (JD 70,000: GTZ, UNDP, etc.). The operation/equipment budget (around JD 4,400 or US\$ 6,300 per pRY) could not cover the research needs and implied a rather large underemployment of the staff.

Scientific cooperation with the other NARS institutions, considered insufficient some years ago<sup>1</sup>, has increased, especially with the UOJ Faculty of Agriculture, as a result of the improvement of the financial situation of NCARTT which allowed the association of the academic staff members with the research programs of the Center. Being part of MOA, NCARTT has strong linkages with extension and directorates of agriculture in the governorates of the Kingdom. NCARTT has always given strong attention to scientific relations with institutions of developed countries (USA, Germany, etc.) and intern collaborative research programs.

#### **The Water and Environment Research and Study Center (WERSC, UOJ)**

WERSC is an autonomous institution supervised by a Board of Directors whose members are chosen by the UOJ Council of Deans from inside and outside the University based on their interest in water and environmental issues.

##### Resources

The Center has 20 full-time scientists on duty (6 PhD, 6 MS, 8 BS), and 3 more preparing PhD degrees outside, who dedicate around 60% of their time to research, 30% to education, and 10% to other activities (services: soil/water analysis; consultancies). Only about 60% of the research activities at WERSC are AR-related (the other 40% concern hydrology, urban water and pollution issues, etc.). Therefore, an equivalent of about 8 full-time WERSC scientists are actually involved in AR. WERSC also mobilizes 20 part-time UOJ staff members working around 20% of their time at the Center (5 from FA, 15 from other faculties). Thus, the pRYs of WERSC amount to 10 (of which 2 come from the other UOJ institutions).

The permanent support staff is limited (3 lab technicians, 3 laborers, 1 secretary); but WERSC uses laborers from the farm of the UOJ Faculty of Agriculture (FA) located in the Jordan Valley.

WERSC physical resources at the UOJ campus are good. It has permanent access to the large water treatment plant close to Amman, and to physical resources of other UOJ units (labs and farm of FA, labs of the Faculties of Sciences and of Medicine).

In 1997, WERSC total annual financial resources amounted to JD 780,000, of which 230,000 came from national sources<sup>2</sup> and 550,000 from foreign grants (through projects funded by the USA, UNDP, EU, Canada, the Netherlands, etc.). The total annual financial resources allocated to AR amount to (approximately) JD 400,000. The operational/equipment budget (around JD 670,000 or US\$ 940,000) is largely allocated to research activities, and is considerably high (about US\$ 40,000 per pRY).

##### Research Activities and Linkages

AR projects deal with irrigation at the farm level, water harvesting, and use of wastewater for irrigation (6, 3 and 3 full-time scientists, respectively). They benefit from strong international scientific support. Linkages with the UOJ units (FA, Faculty of Sciences, etc.) are important and are developed through the mobilization of permanent and part-time staff coming from these units. Linkages with NCARTT are rather weak.

#### **The Marine Science Station (MSS) of Aqaba**

This Station, which is affiliated to UOJ and Yarmouk University, has 5 full-time researchers (all PhD holders) and 18 support staff (technicians, clerks, etc.), good physical facilities (including seven labs, a research boat, and the Marine Nature Reserve surrounding the Station, with access limited to scientists), and a national budget of JD 200,000.

MSS conducts research activities on oceanography, marine chemistry and pollution, coral reef ecology, fish biology, fisheries and aquaculture. It has published recently two books on the fishes and corals of the Gulf of Aqaba.

### **2.3 The Five Faculties of Agricultural Sciences (FASs)**

#### **Overview**

The five FASs are:

- The FA at the University of Jordan (FA/UOJ): It is the oldest and largest FAS with 229 permanent national employees, including 74 academic staff (all nationals, including: 54 PhD, 20 MS), 44 technicians and 111 other support staff (clerks, laborers).

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<sup>1</sup> See Snobar and Duwayri (FAO, 1996).

<sup>2</sup> Including about JD 70,000 for salaries, JD 50,000 from UOJ for operation/capital, and JD 110,000 from other sources (Jordan Corporation for Environmental Protection, Higher Council for Science and Technology).

- The FA (40 academic staff, including 2 expatriates) and FVM (23 academic staff, including 12 expatriates) at the Jordan University of Science and Technology (JUST), based at Irbid in the north.
- The FA at Muta University (19 academic staff, including 3 expatriates), in Kerak in the south.
- The FA at the private University of Jerash (24 academic staff, including 6 expatriates), located midway between Amman and Irbid.

The four public universities are autonomous public or semi-public institutions of the Ministry of Higher Education; the private university is governed by a Council of Deans. The main activity of the FASSs is teaching: all grant BS degrees, FA/JUST grants also MS degrees, and FA/UOJ MS and PhD degrees.

There are 181 academic staff members with high qualifications in the five FASSs: among them are 157 nationals (114, 30, and 13 with PhD, MS, and BS, respectively); and all the 24 expatriates have PhD degrees. Altogether they represent 49 potential RYs<sup>1</sup>.

### Research Activities

The availability of highly qualified staff and of students who could be associated with research activities (particularly from the graduate study programs) offers large comparative advantages for the FASSs to implement AR programs; however, research is constrained by several factors (Snobar and Duwayri, 1996):

- Staff members with PhD degrees are appointed mainly for teaching. Therefore, when they carry out research, it is mostly based on individual initiatives and for academic advancement purposes rather than for the development of the agricultural sector.
- Research at the universities lacks coherent policies and management structures.
- Time available for research is rather limited because of the heavy teaching loads dictated by the excessively high numbers of students: at FA/UOJ and FA/JUST, enrollment totaled 1430 and 600 students, respectively, in 1996/97 (ratio of students to academic staff member 12:1 and 15:1).
- Research resources are rather limited: technicians are scarce (only 0.6 per staff member at FA/UOJ, and 0.3 at FA/JUST) and mainly mobilized by education activities; for most of the FASSs, physical and financial resources are essentially allocated to training activities, and research facilities, equipment and funds are considered insufficient.
- Contacts are limited between academic staff members and farmers or extension agents in the field. Therefore, AR activities carried out at the FASSs are often not of problem-solving nature, or, when they are, results often remain in publications and not readily available to farmers, and therefore not applied.

So far, only FA/UOJ has been actively engaged in AR (some 500 papers published in various agricultural disciplines since 1972). It is worth mentioning the Jordan Arid Zone Productivity Project (JAZPP), funded by the European Union (US\$ 0.9 million for 5 years, of which US\$ 0.35 million was in 1997) and implemented with NCARTT<sup>2</sup>. AR ble impact, particularly in improvement of cereal, food legume and forage production

particularly the Muta and Jerash FAs which have not yet established research facilities. As a consequence, the time actually allocated to research at the FASSs should not exceed 10 or 15%, which would give 20 to 30 actual RYs for the five FASSs.

<sup>1</sup> analysis of all the WANA NARS (see methodology of the study).

opted for the

<sup>2</sup> JAZPP is an applied research project concerned with improving agricultural productivity in a zone of Jordan that receives between 100 and 200 mm of rain annually. Its approach combines: (i) Evaluation of natural resources at the level of small drainage catchment leading to land use recommendations for each catchment, (ii) Development and testing of appropriate production methods, and (iii) Socioeconomic evaluation of proposed technical acceptability (JAZPP Newsletter, April 1998). JAZPP mobilizes 33 senior team members (20 academic staff members mainly from FAO/UOJ, 5 NCARTT researchers, and 8 professional staff members from MOA) who allocate an average of around 10% of their time to the project, 32 other people (mostly trainees and students from UOJ), and 1 expatriate (research coordinator).

## 2.4 The Other NARS Institutions<sup>1</sup>

### The Other Faculties (Sciences, Economics, etc.)

Some faculties of sciences and economics have a relatively large number of staff members who are highly qualified in AR-related scientific fields (natural resources, plant and animal biology, agricultural engineering, food processing, rural social sciences). A precise inventory of this potential is not available, but according to a rough survey, this number should reach at least 40 academic staff members (including those of the UOJ Faculty of Sciences involved in the AR research activities of WERSC), who represent 10 pRYs.

### The Agricultural Marketing Organization (AMO)

AMO, established in 1962 (restructured in 1987), is a semi-autonomous public institution governed by a Board of Directors chaired by the Minister of Agriculture. Its mandate covers marketing policy formulation as well as the provision of several technical and regulatory services framed to develop the marketing system. AMO has a Directorate of Studies and Information and a Directorate of Post-harvest Technology. During the last years it has carried out several market studies that addressed marketing issues of fresh fruits and vegetables. Its 27 full-time senior staff (1 PhD, 10 MS, 16 BS) allocate around 25% of their time to AR.

## 3. AR RESOURCES

### 3.1 Human Resources (see Table 1)

In 1997, the Jordanian NARS included almost 450 scientific and technical senior graduate staff (including 24 expatriates), representing around 198 potential RYs.

Out of the 358 national senior staff members of the NARS agricultural scientific institutions (AR institutes and FASs), 141 have PhD degrees (39%), 109 MS (31%) and 108 BS (30%). The level of academic training is quite good at the FASs (73% with PhD degrees) but insufficient at the AR institutes (only 13% are PhD holders, and 9% at NCARTT). The recent improvement of the status and salaries of the NCARTT researchers opens possibilities for better equilibrium in the future.

The high concentration of the scientific potential in and around Amman, justified when the NARS had few qualified staff and limited physical facilities, has decreased throughout the last 10 years with the creation of the NCARTT regional centers and the FASs of the Universities of Irbid, Muta and Jerash. However, it remains too high: NCARTT headquarters and the NARS institutions based in the capital (WERSC, FA/UOJ, AMO) concentrate about 60% of the total senior graduate staff and of the total pRYs, and this ratio is much higher for the PhD holders.

In general, the numbers and skills of technicians and other support staff (laborers, clerks) are insufficient due to the very low salaries offered by the public institutions and to the possibilities for technicians to prepare higher diplomas.

### 3.2 Physical Resources

The most important physical resources of the NARS are within the NCARTT units (headquarters, regional centers, farms), which are rather well-equipped and evenly distributed in the country. The FASs are less endowed, with the exception of FA/UOJ.

In general, land is sufficient, libraries/documentation services are considered satisfactory, but the other physical resources (offices, farm buildings, laboratories; scientific/computer/transport/communication equipment) will require efforts in the near future for maintenance and/or modernization.

### 3.3 Financial Resources

In 1997 (see Table 1), the total NARS AR financial resources amounted to around Jordanian dinar (JD) 4.3 million (US\$ 6.1 million), of which JD 3 million (US\$ 4.3 million) came from national sources (mainly the Government budget, and some self-earned institution resources and donations by private sector organizations in support of special

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<sup>1</sup> The following list does not include: (i) the Royal Scientific Society, established in 1970, now one of the HCST research and development institutions, which does not have a section for agriculture, but its agriculture-related activities include the analysis of pesticide residues, recycling of plastic material, and industrial pollution; nor (ii) the private sector: some agricultural and agro-industrial companies have established their own experimental stations, mainly used for testing new crop varieties or agricultural inputs before their release to farmers (a precise inventory of their AR activities and resources should be done).

research activities), JD 0.15 million as a loan (from the World Bank to NCARTT), and JD 1.14 million (US\$ 1.6 million) from external grants, essentially secured through bilateral or multilateral donors.

The AR national and total resources amounted to around 0.72 and 1%, respectively, of the Agricultural Gross Domestic Product (AGDP estimated at US\$ 600 million in 1996). Such ratios are close to the 1% recommended by some international organizations and are above those registered in most of the WANA countries.

NCARTT and WERSC currently enjoy good financial resources and can provide sufficient means to their researchers on duty. On the other hand, the FASs suffer from low operating and equipment research budgets, which prevent (with other factors) a fair mobilization of their scientific potential. Therefore, the NARS should account for around 120130 actual RYs (about 80 for NCARTT, 8 for WERSC, 2030 for the FASs) against the 198 pRYs estimated above. This statement pledges for an increase of the national financial resources to take into account the needs of the NCARTT and WERSC researchers now on study leaves, the research needs of the FASs, and for keeping an acceptable balance with the foreign grants.

#### 4. RESEARCH ACTIVITIES

##### 4.1 Research Orientation

The National Strategy for Agricultural Research and Technology Transfer, formulated by NCARTT in 1996 with the support of ISNAR and ICARDA, mandated the universities with basic research, while NCARTT was mandated to focus on applied research and transfer of technology. It organized research along three dimensions: production-system research (irrigated agriculture, rainfed agriculture, low rainfall areas, and integrated livestock), commodity research (vegetables, fruits, field crops, etc., forest, sheep and goats, cattle, etc.), and non-commodity research (water resources, soil and land resources, etc.). The main research thrusts favored are irrigated agriculture (23% of the RYs), rainfed agriculture (17%), low rainfall areas (19%), integrated livestock (22%), plant genetic resources (8%) and water management and environment (11%). Forestry and food technology are not adequately covered in the strategy.

This strategy is being followed by NCARTT, but does not serve as an active reference for the FASs and the other NARS institutions.

##### 4.2 Linkages and Collaboration

Linkages between the NARS institutions are achieved through different means (memberships in councils, participation of FAS staff members in the NCARTT research committees, joint research activities and publications by scientists from different institutions, joint field days, seminars), but not through a well-defined system.

A recent review of research and technology transfer activities indicated a substantial gap in the linkages between the NARS institutions, which resulted in duplication of effort and waste of resources. It recommended setting up a broad-based research committee able to strengthen linkages and coordination among these institutions and to determine where AR efforts can best be allocated to meet the most urgent research and technology transfer needs.

Relationships with development agencies, extension services and farmers are, in general, well-established for NCARTT, primarily through the MOA Directorate of Agricultural Extension and Information (AEID, established in 1993), which is mandated to carry out agricultural extension activities and to cooperate with NCARTT in technology transfer and dissemination<sup>1</sup>. The mandate of the FASs does not include any form of institutional relationship with extension services or farmers; thus, contacts with farmers and extension workers are made essentially on an individual basis according to the research outputs available.

International cooperation is widely developed for most of the NARS institutions. It provides technical or financial assistance for training and research activities or for information, and for collaboration with the CGIAR centers (among them, ICARDA is the most important), scientific institutions from developed countries (UK, Germany, USA, etc.), and from neighboring countries. These relationships are strongly supported by international aid agencies (UNDP, World Bank, IFAD, EU, etc.) and by regional organizations (AARINENA, ACSAD, AOAD).

#### 5. CONCLUSION

NCARTT and FA/UOJ are only 13 and 25 years old, respectively. It is dominated by the two main institutions or sets of institutions represented by NCARTT and the FASs, which have complementary characteristics. NCARTT has relatively low-qualified scientists but is endowed with other good human (technicians, support staff), physical, and financial resources. On the other hand, the FASs

<sup>1</sup> This Directorate has recently developed a National Strategy for Agricultural Extension, which will be implemented from 1998.

enjoy an excellent reputation in the region with regard to the quality of their academic staff and graduate students, but such record is not matched in the research area for which research support staff and physical/financial resources are very limited. In these conditions, the weakness of their linkages means a rather unsatisfactory use of the total available resources.

The adoption, in 1996, of a National Strategy for Agricultural Research and Technology Transfer was an important achievement that should put AR in Jordan on the right track, as it identified the national efforts to be devoted to the different subsectors of agriculture, determined the roles of the NARS institutions and their contributions to those efforts, and identified the most appropriate linkages and cooperation modalities among these institutions and between the NARS and the extension services. This should help to achieve stronger interrelationships and active complementarity, which should be the only proper way to address national issues under the constraints of limited financial resources. However, such objectives require the adoption of numerous measures aimed towards progressive association and integration of the human, physical and financial resources of the two main institutions of the NARS.

The pressure on the agriculture sector in Jordan is increasing due to increasing land fragmentation, continued shortage of water and deterioration of its quality, encroachment of urbanization on prime agricultural land, competition at the international markets, etc. AR will be needed more and more for properly addressing such issues. The growth of the NARS and the development of its capacity will be highly dependent on the quality of output and satisfaction of the clients, and also on the solution of the current dual structure of the NARS, which is necessary for improving the efficiency of the scarce financial resources available.

## Main Acronyms

MHE: Ministry of Higher Education. MOA: Ministry of Agriculture.

FASs: Faculties of Agric. Sciences (= FAs + FVM/JUST). FA: Faculty of Agriculture. JUST: Jordan Univ. of Science and Technology (Irbid). NADP: National Agric. Devel. Project. NCARTT: National Center for Agric. Res. and Technology Transfer. UOJ: Un. of Jordan (Amman). WERSC: Water and Environment Res. and Study Center.

JD: Jordanian dinar (1 JD = US\$ 1.41).

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**Table 1 - The National Agricultural Research System (1997/98)<sup>a</sup>**
<sup>a</sup> Most of the human resources: 1998; most of the financial resources: 1997. *Italics*

NARS Institutions				AR Scientific & Tech. Graduate Staff (Units)			Potential Research Years*			Total Budget (1000 JD)		AR Expenditures/Resources (E) (1000 JD)						
No.	Name - Acronym Head Office - Year Established	Mandates AR Fields	Govern. Ministry	Nationals Total - (PhD, MS)		Exp.	Total	Nat.	Exp.	Total	Nat.	Exp.*	Nat. NE	Loan LE	For. FE*	Total TE		
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q		
1.1	National Center for Agr. Res. & Technology Transfer Amman	NCARTT 1951-85	AR (70%) - (AD) All	MOA	173	16	70	0	173	121	121	2500	900*	2100	150	600	2850	
2.1	Water/Environment Research & Study Center Amman (UOJ)	WERSC 1982	AR (40%) - R - HE Water	UOJ/MHE	23*	6	9	0	23	8	8	230	550	120		280	400	
2.2	Marine Science Station Aqaba (UOJ, Yamouk Univ.)	MSS 1974	AR (80%) - (AD) Fisheries	UOJ-YU/ MHE	5	5	0	0	5	4	4	200		150			150	
1/2	Total AR Institutes				201	27	79	0	201	133	133	2930	1450	2370	150	880	3400	
3.1	Fac. of Agriculture, Univ. of Jordan (UOJ) Amman	FA/UOJ 1962, 73	AHE - (AR: 30%) All	MHE	74	34	20	1*	75	19	1*	20	930	400	230	200	430	
3.2	Fac. of Ag., Jordan Univ. of Sc. & Technol. (JUST) Irbid	FA/JUST 1986	AHE - (AR: 30%) All	MHE	38	27	1	2	40	10	1	11	630	60*	190	20	210	
3.3	Fac. of Veterinary Medicine, JUST Irbid	FVM/JUST 1990	AHE - (AR: 25%) Anim. prod./health	MHE	11	11	0	12	23	3	4	7	430	40	110	10	120	
3.4	Fac. of Agriculture, Mutah University Karak	FA/MU 1994	AHE - (AR: 10%) All	MHE	16	7	4	3	19	4	1	5	150	20	10	10	20	
3.5	Faculty of Ag., Jerash University Jerash	FA/JU 1993	AHE - (AR: 10%) All	Private	18	15	3	6	24	5	1	6	170	40	10	10	20	
3	Total Agricultural Sciences Faculties				157	114	30	24	181	41	8	49	2310	560	550	250	800	
4.1	Faculties of Sciences, Economics - UOJ, JUST, ...*		HE - R (AR) Diverse*		40	30	10		40	10		10		80		-	80	
4.2	Agricultural Marketing Organization Amman		AMO 1962-87	AD - AR (25%) Rural economics	MOA	27	1	10	0	27	6	6	80	40	20	10	30	
4	Total Other Institutions				67	31	20	0	67	16	16	80	40	100		10	120	
5	Total NARS (approximate)				425	172	129	24	449	190	8	198			3020	150	1140	4310
Exchange Rate: 1 Jordanian dinar (JD) = US\$ 1.41, US\$ 1 = 0.71 JD (1996 average rate)					Actual Research Years (aRYs) (Estimate) →						120/130		AR Expendit. (million US\$) →		4.3	0.2	1.6	6.1

MOA: Ministry of Agriculture, MHE Ministry of Higher Education.

**e: Mandates:** AR (... %): Approximate average % of human resources devoted to ag. research (AR); R: Research, AEHE Ag. higher education; AD: Ag. development/services (for AR and AEHE institutes: seed production, soil and water analysis, extension, studies, etc.). **h, j:** Potential research year (pRY) = equivalent full-time researcher; for the FASs, the pRYs have been estimated by multiplying the number of academic staff by 0.25, n: For the AR  $0.5 + 0.5(100\% - 0.5)$ , 0.5 being the % of time devoted to AR by the graduate staff, p: For estimating the external grants, the cost of the expatriates is calculated on the basis of the average cost of national scientists.

\* **Notes:** 1.1: NCARTT: m: Including the World Bank loan. 2.1: WERSC/UOJ: 23 full-time scientists, of whom 3 are preparing PhD outside + 20 part-time UOJ academic staff members (of whom 5 are from FA) counted in lines 3.1 and 4.1. 3.1: Researcher. 4.1: Only academic staff members specialized in AR-related sciences (including the 15 ones from the UOJ Faculty of Sciences working part-time with WERSC) are mentioned.

National AR expenditures (NE): 0.72% of the Agricultural Gross Domestic Product (AGDP: US\$ 0.6 billion in 1996). Total AR expenditures (TE): 1% of the AGDP.

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF LEBANON<sup>1</sup>

## 1. HISTORICAL BACKGROUND

Public agricultural research (AR) in Lebanon dates back to the establishment of Tal Amara station in the Bekaa Valley immediately after independence (1946) as an agricultural training center, supported by French technical assistance. Later, in 1957, it became the Department of Agricultural Scientific Research (DASR) of the Ministry of Agriculture (MOA). Other stations were established at Terbol (Bekaa) for animal production, Kfardane (Bekaa) for dryland farming, Abde (north) and Tyre (south) for citrus.

In 1964, DASR was reorganized as an autonomous public institution and became the Lebanese Agricultural Research Institute (LARI) affiliated to MOA. More research stations were established at Fanar (Mount Lebanon) for animal health and agriculture, at Kfarsghhna (north) for olive and citrus improvement. Both Terbol and Kfardane research stations were later (in the late 1970s) handed over to the International Center for Agricultural Research in the Dry Areas (ICARDA).

The National Council for Scientific Research (NCSR or *Centre National de la Recherche Scientifique*: CNRS) was established in 1962 with the mandate of promoting, supporting, and coordinating the national research policy. It has also direct responsibility of five specialized centers, one of which is the National Marine Research Center set up in 1975 at Jounieh, then moved to Baroun and renamed the National Center for Marine Sciences (NCMS)<sup>2</sup>. NCSR supports some contracted AR projects at both LARI and the university research system.

The first faculty of agriculture (FA) established in Lebanon was the (private) Faculty of Agricultural and Food Sciences (FAFS, 1952) of the American University of Beirut (AUB). Other FAs were opened later: the Faculty of Agricultural Sciences of the (public) Lebanese University (FAS/LU, 1985), and two other private ones (ESIAM/USJ, 1979; FSA/USEK, 1988).

## 2. THE CURRENT NARS (1996)

### 2.1 Overview

The Lebanese NARS is made up of three sets of institutions:

- The scientific institutions which have AR as their central mandate: LARI and NCMS: they account together for 65% of the potential research years (pRYs: equivalent full-time researchers) and 88% of the total financial resources of all the NARS; these two institutions are presented in Section 2.2.
- The four faculties of agriculture, which are more or less involved in AR, account for 28% of the pRYs and 11% of the total financial resources of the NARS (see Section 2.3).
- Few other scientific institutions, which allocate some resources to AR (around 7% of the pRYs and 1% of the financial resources of the NARS); they will be briefly seen in Section 2.4.

NCSR, responsible for the national scientific policy, has a limited role in the NARS. There is no body for coordinating the NARS institutions; however, LARI is recognized as the national AR leader. It is worth mentioning that it was responsible for the preparation in 1996 of the Lebanese AR Strategy (LARS) adopted by the Government.

Outside the NARS, AR activities are also carried out by: (i) some private business companies aiming at promoting sales of seeds, transplants, fertilizers, pesticides, new products and modern technology outputs; (ii) ICARDA at the Terbol and Kfardane stations; and (iii) some NGOs (see Section 4.2).

<sup>1</sup> By **Dr Mouin Hamzé**, Secretary General, NCSR, Beirut, and member of ICARDA Board of Trustees; **Dr Wafa Khoury**, FAS/LU, Beirut; and **Dr Michel Abi Antoun**, LARI, Tal Amara, Bekaa.

<sup>2</sup> The other Centers are related to scientific computing; geophysics; solar energy; remote sensing, atomic energy, documentation, scientific information.

## 2.2 The AR Institutions

### The Lebanese Agricultural Research Institute (LARI)

**Mandate and Organization** - LARI is the main NARS institution: it gathers around 53% of the pRYs and 85% of the total financial resources of the NARS. It is an autonomous public institution governed by a council which includes representatives of the main scientific institutions and agricultural stakeholders<sup>1</sup>. Its main mandate is AR, which occupies more than 90% of the time of the senior research staff. AR undertaken is in all major fields: field crops, horticulture, crop protection, animal production and health, food technology, and socioeconomic. LARI also conducts some development activities (production of quality seeds, soil analysis, food quality control, etc.).

**Human, Physical and Financial Resources** - In 1975, LARI had 55 researchers (supported by 66 technicians). This number was highly affected by the civil conflict and sharply reduced through immigration, retirement and death, and through the low salaries and benefits which were not conducive for retaining the remaining research staff. Till 1995, attempts to recruit researchers were hampered by governmental restrictions and by the low salaries. Realizing that most of the researchers were over 50 years old, the Government recently recognized the importance and urgency of new recruitments, offering competitive salaries.

LARI currently (April 1998) has around 329 national permanent full-time staff, including:

- 49 graduate research staff, of whom 48 are nationals (18 PhD, 15 MS, and 15 BS and equivalent diploma in veterinary degrees and chemical engineers), and one expatriate, who represent 44 pRYs<sup>2</sup>;
- 50 laboratory and field technicians and 230 other supporting staff (clerks, accountants, laborers, etc).

The new recruited senior researchers are mostly fresh graduates from European universities (mainly France, the United Kingdom, Italy and Germany) and are of the age group of 30–40 years. They receive salaries comparable to those of professors at the national university, which range between US \$1000 and 1500 monthly. The research assistants are also young fresh graduates (BS and MS) from Lebanese, Arab or European universities.

The current ratio of technicians per researcher is around 1, which is below the accepted standard of 2 technicians per researcher, whereas the ratio of other support staff per researcher is around 5, which is slightly higher than the general standard of 3–4.

The Institute operates through seven experimental stations (Tal Amara, Terbol, Kfardane, Kfarsakhna, Abdeh, Sour, Fanar, total area: 280 ha), located in all the agroecological zones of the country. The stations are divided into units or sections either by discipline or by crop. During the years of civil conflict, all research stations suffered from intensive loss in most physical resources such as buildings, farm machinery, field and laboratory equipment, transport vehicles, supplies and support services. Towards the end of 1990, rehabilitation of all stations started, beginning with the main station of Tal Amara. At present, the main stations have generally sufficient land allocated for field research, relatively adequately equipped laboratories, and some transport vehicles. What is still not available are the research support services such as libraries, documentation centers, computer networks, maintenance and repair workshops for equipment and machinery, genebank collections, etc.

The actual annual governmental budget allocated to LARI for 1997/98 amounted to around US\$ 3 million<sup>3</sup>, of which 60% was allocated to salaries and 40% to operation/capital costs (OCC). The contribution of NCSR through contracted research projects (around US\$ 10,000) and the support through bilateral and multinational donors (estimated at US\$ 250,000, without considering fellowships) were essentially allocated to OCC. Accordingly, OCC amounted to around US\$ 1.26 million, i.e., around US\$ 26,000 per pRY, which allows an actual full employment of the researchers<sup>4</sup>.

**Research Activities and Linkages** - Although researchers were recruited at LARI from various disciplines, there are still several areas of research in which specialists are missing and accordingly research is lacking. These include, among others, horticulturists, fruit tree breeders and postharvest technology specialists, nematologists, animal breeders and veterinary doctors, ecologists and forestry specialists, economists, sociologists, statisticians and computer specialists. Disciplines required are clearly described in the 1996 national Lebanese Agricultural Research

<sup>1</sup> Among the members: representatives from MOA, some FAs, and the private sector, besides the LARI Director General.

<sup>2</sup> pRYs = Number of researchers on duty × 90% (percentage of the researchers' time devoted to AR).

<sup>3</sup> The LARI official budget was double, but only one-half of it was actually allocated.

<sup>4</sup> Which means a slightly higher amount per pRY, very close to the "optimal" amount of OCC used in the long-term plans drawn up by some developing countries in similar agroecological conditions, estimated at US\$ 25,000–30,000 per pRY.

Strategy (LARS, 1996). Although research at LARI has been oriented towards the projects proposed by LARS, the very limited recruitment of researchers since that time did not allow the fulfillment of the proposed goals.

Cooperative research projects at LARI are implemented in various fields with some foreign/international institutions: wheat, barley, grain legumes, pasture and forage with ICARDA; olive propagation and improvement with FAO; quality control on food and water with FAO; plant protection (insect male sterile technique on the citrus Mediterranean fruit fly) with IAEA and in collaboration with NCSR; certification program for fruit tree production with CIHEAM; etc. International agencies such as FAO, UNDP and ICARDA, who sponsored LARI in the past, are expected to continue their support for local and regional development and progress.

Several other collaborative projects are being conducted with regional institutions, mainly in Syria (citrus and sugar beet improvement research), as well as with national institutions, such as all the FAs, NCSR, and various ministries.

### **NCSR - National Center for Marine Sciences (NCMS)**

NCMS currently has 15 national permanent staff, including 11 researchers (3 PhD, 4 MS, 4 BS)<sup>1</sup> and 3 technicians. Research in NCMS is conducted on biological oceanography, aquaculture and environmental monitoring studies on fish and seawater.

The Center is furnished with laboratory equipment needed for conducting basic studies in freshwater and the coast, but is in need of further laboratory equipment, a boat to conduct studies at further depths of the sea, and of more researchers, technicians and administrators.

Research at NCMS is usually done in cooperation with national institutions such as the Ministries of Agriculture and Environment, the Lebanese Army Marine, and the national FA, as well as some European and Syrian research institutions. Several research projects are undertaken with the support and collaboration of international and Mediterranean organizations and networks.

## **2.3 The Faculties of Agriculture**

### **Overview - The four FAs are:**

- The Faculty of Agricultural Sciences of the Lebanese University (FAS): It is the unique public FA; it mobilizes 32 permanent national academic staff (22 PhD, 8 MS and 2 BS including research assistants) and around 42 part-timers; it hosts 240 students.
- The private Faculty of Agricultural and Food Sciences of the American University of Beirut (FAFS/AUB): It is the oldest FA, with around 40 full-time academic staff (24 PhD, 3 of whom are expatriates, 6 MS and 10 BS), supported by 3 part-time academic staff members and 7 part-time research assistants; among its 300 students, around 77 are graduate (MS studies).
- The private *Ecole Supérieure des Ingénieurs Agronomes Méditerranéens* of the Saint Joseph University (ESIAM/USJ): It has a small permanent academic staff (5 nationals, including 3 PhD and 2 MS; 2 expatriates), supported by 32 part-time staff (coming mostly from FAS); its total student body is around 80.
- The private *Faculté des Sciences Agronomiques du Saint-Esprit* (FSA/USEK): It is the youngest FA, with a limited permanent academic staff (10 nationals: 3 PhD, 5 MS, 2 BS), supported by 47 part-timer staff (coming also mostly from FAS); it hosts 160 students.

All the FAs offer BS or “*ingenieur*” degree (5 years). FAFS/AUB also offers an MS degree. A new joint DEA program (equivalent to MS) has been recently set up by the French-speaking universities (FAS, ENSIAM, FSA) with the support of AUPELF and France (which provide teaching/research staff coming mainly from INRA and INAP/G)<sup>2</sup>; during the academic year 1996/97, 12 students were registered for this DEA program.

**Resources** - The four FAs have 89 academic and senior research staff members, of whom 84 are nationals, including 49 PhD and 21 MS holders. They form the large majority of the highly qualified staff of the NARS.

<sup>1</sup> The Center also has 5 senior researchers from other institutions (mainly the Faculty of Sciences of the Lebanese University: see Section 2.4), who collaborate on a project basis.

<sup>2</sup> AUPELF: *Association des Universités Parlant Entirement la Langue Française* (Association of the Francophone Universities). INRA: *Institut National de Recherche Agronomique*, INA P/G: *Institut National Agronomique de Paris-Grignon*.

All of the private FAs enjoy relatively good physical resources. The public FAS enjoys good laboratory facilities developed mainly through international cooperative programs and donations from France and Italy, but does not have a training and research farm. FAFS has a well-equipped Agricultural Research and Educational Center (AREC) of an area of 120 ha located at Haouch Sneid (Bekaa Valley), which includes experimental and production fields; greenhouses; poultry houses; dairy cow, sheep and goat barns; machinery sheds and workshops; lecture halls; laboratories; offices; dormitories; a cafeteria; and faculty residence buildings. ESIAM has faculty teaching and laboratory buildings in Taaanayl, the Bekaa, and has a large farm (200 ha) with fruit tree orchards, vineyards, fields, and animal barns designated for production, student training and research activities; its laboratories are furnished with modern equipment sponsored by the French Government.

The financial resources of the FAs come from a number of sources (government allocation, national private sector, self-generated resources, external funds), which have been roughly estimated at more than US\$ 1.8 million, including US\$ 1 million from national sources and 0.8 from external sources (which definitely sponsor a large part of the financial resources at ESIAM and FSA).

**Research Activities** - Research is recognized to be as important as education by the FAs, which have rather good comparative research advantages over other institutions. These are the presence of highly qualified scientists, good physical facilities, need for students to undertake a research project to fulfill their graduation requirements (during the fifth year for FAS, ESIAM and FSA, and during the MS graduate program at FAFS). However, AR in the FAs suffer from a number of major constraints and limitations, which are mainly:

- The lack of research policy of the FAs.
- The limited availability of academic staff members for research activities, due to the heavy teaching loads induced by the rather high number of students (an average of 9 students per permanent academic staff member in the four FAs) and, often, to the needs (with regard to their low salaries) for getting complementary income through extra-hour courses or other activities.
- The lack of skilled technicians and the limited national and external funds for research.
- Limited financial research resources, coming mainly from low internal university funds, research contracts with NCSR, cooperation projects with LARI, local private sector, or external support (bilateral agencies, international AR centers).

Accordingly, AR is currently carried out mainly by young staff members and graduate students, with limited direct involvement of the academic staff (especially in ESIAM and FSA); and it seems realistic to consider that the FAs actually dedicate around 10 to 20% (as an average) of their human and financial resources to AR, which means that the four FAs represent around 9 to 18 actual RYs.

## 2.4 Other NARS Institutions

Outside the FAs, other public and private faculties have highly qualified scientists in AR-related fields (plant and animal biology, agricultural engineering, food processing, rural social sciences); a precise inventory of this scientific potential and these research activities is not available, but 16 academic staff members are currently benefiting from research funds from NCSR, including 12 at the Faculty of Sciences of the Lebanese University, involved part-time in research on hydrobiology and entomology; and 4 at the Department of Biology of AUB, involved in research on crop biology, water management and animal physiology. Two researchers from the National Center for Remote Sensing of the NCSR are involved in a research project on crop production, funded by NCSR.

The Tobacco Monopoly (*Régie des Tabacs*), a public enterprise, is conducting research on tobacco, but no published information is available on the related activities and resources.

## 3. AR RESOURCES

### 3.1 Human Resources

In 1997 the Lebanese NARS involved 159 scientific and technical senior graduate staff (including 5 expatriates), who represent around 83 potential RYs (see Table 1).

Among the national senior staff, around 78 have a PhD degree (49%), 52 an MS (33%), and 29 a BS (18%). The level of academic training is quite good in all the FAs (58% with PhD) and less at LARI (38% with PhD). The recent improvement of the status and salaries of LARI researchers opens possibilities for better equilibrium in the future.

NARS scientists are highly concentrated in and around Beirut (64% of the total graduate staff), but LARI is contemplating allocating a large part of the newly recruited researchers in stations in other parts of the country.

Salaries of researchers in the NARS vary between the public and private institutions. Recently, LARI was able to attract new research staff by providing salaries that are comparable to those of the academic staff at FAS. In both public institutions, however, salaries are still way below (almost half) those at the private FAs.

In all the Lebanese NARS institutions, there is still a need for highly qualified and trained technicians and the number of supporting staff is relatively on the lower end.

### 3.2 Physical Resources

The research activities in Lebanon are implemented in a network of laboratories and research stations that are rather well distributed, with research stations in the coastal areas (Beirut/Fanar, Sour, Abde, Kfarshakha of LARI and the main laboratories of FAFS and FAS in Beirut), and three in the inland country: Tal Amara, Terbol and Kaa (LARI), Haouch Sneid (FAFS/AUB), and Tannail (ESIAM/USJ).

As previously mentioned, physical resources are generally adequate for adaptive and some basic research, especially at LARI, FAFS/AUB, and ESIAM/USJ, and new equipment is being purchased or provided through foreign assistance. Research support services, which include libraries and documentation centers, computer networks and statistical analysis facilities, and workshops for maintaining and repairing expensive equipment, are still generally less satisfactory.

### 3.3 Financial Resources (see Table 1)

Despite the difficulties faced in collecting precise data related to the financial resources, the total (national and external) AR financial resources of the NARS in 1997 was roughly estimated at around US\$ 3.75 million, of which US\$ 3.25 million came from national sources (mainly the government budget, some self-earned institution resources, and donations by private sector organizations in support of special research activities), and US\$ 0.5 million from external funds essentially secured through bilateral or multilateral grants.

The NARS national and total resources amounted to around 0.20% and 0.23%, respectively, of the Agricultural Gross Domestic Product (AGDP estimated at US\$ 1.6 billion in 1996). These ratios are much far from the 1 or 2% recommended for developing countries by some international organizations (World Bank, EU); they show that Lebanon is certainly giving low attention to AR.

It is also worth to mention that, except at LARI, most of the NARS institutions suffer low research operating and capital budgets, which prevent the full employment of their scientific potential. Thus, the total number of actual RYs of the NARS may reach around 60, against the 83 pRYs estimated above.

## 4. RESEARCH ACTIVITIES

### 4.1 Lines of Research

Food crops, vegetables, fruit trees, roots and tubers are among the most favorite AR areas. In livestock research, poultry, cattle and veterinary medicine received good efforts, while sheep and goats attract medium efforts. There is a definite shortage of research activities in forestry (agroforestry, wood processing, natural and plantation forests), other animals (rabbits, pigs) and freshwater fish, and, to a lesser extent, in ornamental and medicinal plants, and in farming systems and catchment area management.

The national AR strategy prepared in 1996 with the support of ISNAR and IDRC provides a valuable reference for better equilibrium in the future.

In general, scientists may handle several research projects at one time as most of them are working part-time on research. Their involvement is thus too diluted and their efficiency limited, particularly at the FAs where the objectives of the research projects are largely identified and chosen more on a personal-interest basis than according to the priority needs of the agricultural sector.

AR results of the NARS are published in various scientific journals; international, regional or national. Commonly, research undertaken at the FAs is published in refereed journals and, to a lesser extent, in the scientific publications of NCSR. Previously, LARI had several publications of its own, which, however, were discontinued during the years of

the war. Research results are also presented in bulletins of the NARS institutions, in national and international scientific congresses and meetings, as well as during the annual presentation sessions of the contracted research projects of NCSR.

#### **4.2 Relations with Development and International Cooperation**

These relations are, on the whole, quite satisfactory. The private sector is very active and covers many gaps unwillingly neglected by the research institutions. Research findings are directly transferred to the farming community in the following areas: cereals, root crops, pastures, grain legumes, veterinary medicine, plant nutrition and pest management. Hybrid seed, tissue culture and biotechnology output also reach the farmer via the multi-channel system available in the country (public and private institutions, and the private sector).

As public and local governmental staff and extension agents are few, local, national and international NGOs<sup>1</sup> are playing an increasing role in transferring AR results to the farmers in the various regions of the country as well as in obtaining feedback from the rural community as to their technology adoption and prioritization of needs, and even in applied and field research. The socioeconomic context, usually underestimated by the NARS scientists, is a major component in the approach of the NGOs who are better suited to facilitate local contacts and speed up the spread of on-farm research. NGOs often have good relations with the NARS.

Cooperation emphasizes all possible ways to accomplish better research results and expand it to areas presently not well covered. There exists excellent cooperation with regional and international centers (AARINENA, ACSAD, CIHEAM, ICARDA, CIMMYT, ISNAR, IPGRI, etc.) and organizations (FAO, UNDP, the World Bank, IDRC, etc.). Bilateral cooperation with developed countries (France, Italy, USA) is also important for the NARS.

#### **5. CONCLUSION**

The NARS of Lebanon is almost as old as independence. Over the past 15 years, three new faculties of agriculture were established to add to the formerly existing institutions. The Ministry of Environment and the Ministry of Culture and Higher Education (MCHE) have added more awareness to agricultural and urban practices, which negatively contribute to natural balances in living organisms and to environmental hazards. Rebuilding infrastructure and manpower is a time-consuming process, and the shortage in qualified staff is evident in almost all institutions. What was accomplished in the past few years should be credited to all Lebanese individuals, communities and authorities.

Some important accomplishments have been achieved during recent years such as the recruitment in the various NARS institutes of young, highly qualified researchers; the new infrastructure developed, especially at LARI; the development of the Lebanese AR Strategy; the establishment by NCSR of the National Center for Remote Sensing and the National Atomic Energy Center, which could both provide support to AR in the near future.

However, the NARS is currently suffering major constraints, including the very insufficient levels of national and external resources, the weak coordination between the various NARS institutions, the lack of coordination with respect to international cooperation, the absence of a clear national agricultural policy and of an efficient and effective agricultural extension service, and the lack of basic reliable national data (on population and economic indicators as well on natural resources and agriculture).

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<sup>1</sup> Local NGOs involved in agricultural development are: Aarsal Rural Development Association (Bekaa region), Green Triangle (south Lebanon), Social Youth League (north Lebanon); they get financial support commonly from international NGOs or through associated projects with the universities and ministries, often via the "national" NGOs. The main NGOs working at the national level are Greenline Association (environmental/agricultural/cultural heritage group; mostly agricultural professors and students from UAB), the *Société pour la Protection de la Nature* (SPN; environmental association), Liban Nature and Environment (LINEE; an environmental awareness organization which campaigns with schools), and Green Forum; these receive funds from international agencies through association in research and development projects with universities, ministries, and international research organizations. The international NGOs concerned in Lebanon are Oxfam, Save the Children Federation, World Vision, etc., supported by funds mostly from USA or sometimes European agencies.

## Main Acronyms

**MOA:** Ministry of Agriculture. **MCHE:** Ministry of Culture and Higher Education. **NCSR (CNRS):** National Council for Scientific Research.

**AUB:** American Univ. of Beirut. **ESIAM:** Ecole Supérieure d'Ingénieurs Agricoles Méditerranéennes. **FAFS:** Faculty of Agricultural and Food Sciences. **FAS:** Faculty of Agricultural Science. **FSA:** Faculté des Sciences Agronomiques (Agric. Faculty). **LARI:** Lebanese Agric. Research Institute. **LU:** Lebanese Un.. **NCMS:** National Center for Marine Sciences. **USEK:** Un. Saint-Esprit de Kaslik (Holy-Spirit University). **USJ:** Un. Saint-Joseph

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**Table 1 - The National Agricultural Research System (1997/98)**
*Notes:* Approximate data. ...: Data not available.

NARS Institutions				AR Scientific & Technical Graduate Senior Staff (Units)				AR Potential Res. Years		Total Budget (1000 US\$)		AR Expenditures/Resources (E) (1000 US\$)			
No.	Name - Acronym Head Office - Year Established	Mandates AR Fields	Govern. Ministry	Nationals Total - (PhD, MS)		Exp.	Total	Nat.	Exp.	Nat.	Ext.	Nat.	For. FE	Total TE	
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	
1.1	Lebanese Agricultural Research Institute Tal Amara/Beirut	LARI 1957	AR (90%) - (AD) All	MA	48	18, 15	1	49	43	1	3,100	250	2,950	3,200	
2.1	National Center for Marine Sciences/NCSS Batroun	NCMS/NCSS 1975	AR (90%) - (AD) Oceanog., fisheries	NCSS/PM	11	3, 4	11	10		70	50	60	50	110	
1/2	Total Agricultural Research Institutes				59	21, 23	1	60	53	1	6070	250	3,010	3,310	
3.1	Faculty of Agricultural Sciences/Lebanese Univ. Beirut	FASLU 1985	AHE - AR (25%) All	MCHE	32	22, 8		32	8		300	50	200	200	400
3.2	Fac. of Agricultural and Food Sciences/American Univ. Beirut, Beirut (private status)	FAS/AUB 1952	AHE - AR (25%) All	MCHE	37	21, 6	3	40	9	1	600	150			
3.3	Ecole Sup. d'Ingénieurs d'Agronomie Médit./Univ. St-Joseph, Beirut (private status)	ESIAM/USJ 1979	AHE - AR (10%) All	MCHE	5	3, 2	2	7	1	1	50	500			
3.4	Fac. des Sciences Agronomiques/Univ. St-Esprit Kaslik, Jounieh (private status)	FSA/USEK 1988	AHE - AR (10%) All	MCHE	10	3, 5		10	3		100	100			
3	Total Agricultural Sciences Faculties				84	49, 21	5	89	21	2	1050	800	200	200	400
4.1	Faculty of Sciences/Lebanese Univ., Beirut	FSLU 1985	AR (25%) :	MCHE	12	...		12	4		...	...	40	40	
4.2	Department of Biology/Amer. Univ. Beirut, Beirut	DIB/UAJ 1952	Diverse (see text)	MCHE	4	...		4	1		...	...			
4.3	National Center for Remote Sensing/NCSS Beirut	19...	Remote sensing	NCSS/PM	2	...		2	1		...	...			
4	Total Other NARS Institutions				16	8, 8		16	6	0	...	...	40		40
6	Total NARS		Total --->		139	78, 52	6	165	80	3	...	...	3,250	500	3,750
			Private (included in total) --->		56	...	5	61	14	2			150	150	300
Exchange Rate: US\$ 1 = LL 1545 (1996 average rate)				Total NARS Actual Research Years (aRY) (E) estimate --->				60							

MA: Ministry of Agriculture, MCHE: Ministry of Culture and Higher Education, NCSS: National Council for Scientific Research, PM: Prime Minister, NCSS (CNRS): National Council for Scientific Research.

c: Mandates: AR (... %): Approximate average % of human resources devoted to ag. research (AR); R: Research; AHE: Ag. higher education; AD: Ag. development/services (for AR and AHE institutes: seed production, soil and water analysis, extension, studies, etc.). i, j: Potential research year (pRY) = equivalent full-time researcher; for the FASs, the pRYs have been estimated by multiplying the number of academic staff by 0.25. m: For the AR institutes, AR financial resources have been roughly estimated through the following formula: Total budget  $\times [(0 + 0.5/100\% - 60)]$ ,  $\omega$  being the % of time devoted to AR by the graduate staff.

National AR expenditures (NE): 0.20% of the Agricultural Gross Domestic Product (AGDP, US\$ 1.6 billion in 1996). Total AR expenditures (TE): 0.23% of the AGDP.

## THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF SYRIA<sup>1</sup>

### 1. HISTORICAL BACKGROUND

Since agriculture has been developing in Syria for some thousands of years, experiments conducted by farmers, herders and craftsmen are probably among the oldest in the world. However, formal agricultural research (AR) began very late within the first experimental farms at Deir Elhajar and Kharabo, close to Damascus, in the early 1940s.

After independence in 1946, limited AR activities were carried out by some units of the Ministry of Agriculture and Agrarian Reform (MAAR), along with their other main duties (administration, service, policy formulation, etc.), such as the Directorates of Field Crops, Horticulture, Forestry, Animal Resources, and Plant Protection, then by the Directorate of Cotton Bureau (DCB, Aleppo, created in 1952), the Central Directorate of Citrus Bureau (CDCB, Tartous, 1978), and the Central Directorate of Olive Bureau (CDOB, Idlib, 1980). An AR Council was established in 1959 within MAAR.

The creation of the first AR institution dates back to 1964 when the Directorate of Agricultural Scientific Research (DASR) was established by MAAR as a new additional central unit responsible for almost all AR activities. The Directorate of Soils (DS) was established in 1970 by merging the DASR Soil Department and the Land Use and Water Department of the Directorate of Agricultural Affairs of MAAR. In 1987, the DASR Department of Irrigation and Water Use became the Directorate of Irrigation and Water Use (DIWU).

In 1960, the University of Aleppo established a Faculty of Agriculture (FA), and the Ministry of Education created the High Institute of Agriculture at Damascus, which became in 1963 the Faculty of Agriculture, affiliated to the University of Damascus<sup>2</sup>.

The Faculty of Veterinary Medicine of Hama was established in 1969. Three other FAs were later created; one in Latakia by the University of Tishreen (1971), one in Deir Ez-Zor (1977) by the FA of Aleppo which provided the academic staff during its initial years, and one in Homs (1994).

Other institutions partly involved in AR were established over the last 20 years: the Atomic Energy Commission of Syria (AECS), founded in 1979; the National Remote Sensing Center, created in 1980, renamed as the General Organization of Remote Sensing (GORS) in 1986; and the Environmental and Scientific Research Center (ESRC, 1994).

### 2. THE CURRENT NARS

#### 2.1 Overview (see Table 1)

The public NARS currently includes four sets of scientific and/or technical institutions:

- The AR specialized institutions/units for which AR is the main mandate: they include six directorates under the governance of MAAR (Directorate of Agricultural Scientific Research: DASR; Directorate of Soils: DS; Directorate of Irrigation and Water Use: DIWU; Directorate of Cotton Bureau; Central Directorate of Citrus

<sup>1</sup> By **Dr Hassan Al-Ahmad**, Deputy Minister, Ministry of Agriculture and Agrarian Reform; **Dr Walid El Taweel**, Director, Directorate of Agricultural Scientific Research (DASR); and **Dr George Some**, Director, Directorate of Irrigation and Water Use (DIWU), and member of the Board of Trustees, ICARDA; with the collaboration of **Dr Nourredin Mona**, Professor, Faculty of Agriculture, Aleppo University, and National Scientific Coordinator with ICARDA, **Dr Jouma Abdul-Karim**, Director, Directorate of Soil; **Dr Farid Khoury**, Director General, Cotton Bureau; **Prof. Mahmoud Saleh Soliman**, Director General, Environmental and Scientific Research Center (ESRC); **Dr Adel Safar**, Dean, Faculty of Agriculture, University of Damascus; **Prof. Ibrahim Othman**, Director General, Atomic Energy Commission of Syria (AECS); **Dr Hussein Ibrahim**, Director General, General Organization of Remote Sensing (GORS); **Dr Hamed Kayyal**, former Dean, Faculty of Agriculture, University of Damascus; **Dr Faysal Maya**, Director of Government Liaison, ICARDA.

<sup>2</sup> The roots of the University of Damascus date back to the founding of the Medical Institute in 1903.

Bureau; Central Directorate of Olive Bureau) and the Marine Research Institute (MRI)<sup>1</sup>, affiliated to the University of Tishreen, Lattakia. These seven units gather 66% of the potential research years (pRYs or equivalent full-time researchers) and 70% of the total financial resources of the NARS; they are presented in Section 2.2.

- The six faculties of agricultural sciences (FASs) which are affiliated to the Ministry of Higher Education (MHE): they mobilize around 19% of the pRYs and only 5% of the total financial resources of the NARS (see Section 2.3).
- Other scientific institutions of whose mandate AR activities represent a relatively small part: they are mainly the Atomic Energy Commission of Syria (AECS) and the General Organization of Remote Sensing (GORS), both autonomous institutions affiliated to the Prime Minister, and the Environmental and Scientific Research Center (ESRC) under the Ministry of Environmental Affairs. They represent around 9% of the pRYs and 16% of the total financial resources of the NARS (see Section 2.4).
- Some other agricultural institutions of whose mandate AR activities represent a relatively small part (other MAAR Directorates: Steppe, Mechanization, etc; state enterprises for tobacco and sugar): they fill the remaining marginal place in the NARS and are briefly presented in Section 2.5.

DASR has been given the responsibility for formulating the national AR policy through the identification of constraints limiting agricultural development in the country; however, this function has not been fully developed.

The Supreme Council of Sciences (SCS), based at Damascus, is officially mandated with defining and implementing the national scientific research policy; however, it has very limited influence on the NARS institutions. Accordingly, the national AR policy remains actually split among the NARS institutions (see Section 4).

Some private agro-industrial companies involved in seed, fertilizers, pesticides, and food industries have established their own experimental stations or fields, mainly used for testing new crop varieties or agricultural inputs before their release to farmers. A precise inventory of their AR activities and resources is not available.

It is worth to mention the presence of three international/regional AR organizations in Syria:

- The International Center for Agricultural Research in the Dry Areas (ICARDA), established in 1977 and supported by the Consultative Group on International AR (CGIAR). The Center has a world mandate for the improvement of lentil, barley and faba bean; all dry-area developing countries for the improvement of on-farm water-use efficiency; and a regional mandate (West and Central Asia and North Africa) for the improvement of wheat (in collaboration with CIMMYT), chickpea (in collaboration with ICRISAT), and farming systems. It has around 110 graduate researchers, mostly posted at Tel Hadya, Aleppo, and enjoys excellent physical and financial resources (around US\$ 25 million in 1998).
- The Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), created in 1971 by the Arab League. The Center, based at Douma, Damascus, on the same campus as DASR, DS and DIWU, covers a large spectrum of research fields through its five divisions (water resources, soil, crops, animal production, social studies and planning). Its permanent research staff members and part-time consultants are 17 and 20 PhD holders, and 19 and 34 MS holders, respectively. Its research budget is 75% of its total budget (US\$ 4.4 million).
- The Arab Institute for Forestry and Grazing (IFG), established in 1959 in Bouka, Lattakia. Its main responsibility is training Arab students (diploma degree: two years after high school). It currently (1999) has 4 academic staff members (with PhD) and partly relies on the Syrian universities (Tishreen, Aleppo, Damascus) for its training activities. Its 1998 budget amounted to US\$ 400,000, funded by the Arab Organization for Agricultural Development (AOAD) and fees received from Arab countries for training their students.

## 2.2 The Agricultural Research Institutes

### The Directorate of Agricultural Scientific Research (DASR)

Mandate and Organization - DASR is the major institution of the Syrian NARS, accounting for 36% of the total pRYs and 33% of the total financial resources. It is responsible for research on all crops (except cotton, tobacco, olive trees, citrus) and livestock (except animal health), which is covered by 8 research departments (see research

<sup>1</sup> MRI has been classified in this set of institutions, despite its affiliation to a university, because of its name and its strong commitment to research (as important as training) (see Section 2.2).

activities). DASR researchers allocate around 80% of their time to AR activities, and the remaining time to extension and consultancies. Its headquarters are located at Douma, Damascus.

**Human, Physical and Financial Resources** - DASR has currently (1998) 1400 national permanent full-time staff, 473 of whom are scientific and technical graduate staff members (gsm), 75 technicians, and 852 other support staff (administrative staff: clerks, accountants, etc.; laborers).

The 473 gsm include 47 PhD, 70 MS, 75 Diploma (between BS and MS), and 281 other graduates (275 BS and 6 veterinarians), who represent 378 pRYS<sup>1</sup>. The current academic level of the gsm is considered insufficient; however, it has been significantly increasing over the last years (24 PhD, 9 MS and 217 other graduates in 1983; 34 PhD, 7 MS and 371 other graduates in 1993), due to the efforts made to recruit young scientists and to the relative improvement in salaries (see Section 4.1). The current geographical breakdown of the graduate staff members has improved over the years<sup>2</sup> and is now rather satisfactory.

The ratios of technicians and other support staff to researcher (0.16:1 and 1.8:1, respectively) are much under the general agreed upon standards (2 and 3–4, respectively); however, many BS holders are actually working as technicians.

DASR has 8 research stations around Damascus and 32 others (main stations: Damascus, Aleppo, Hassaké, Lattakia, Homs, Hama, Deir Ez-Zor) sufficiently covering the key agroecological zones of the country. Land resources total around 1000 ha, which are sufficient for the research needs. To a large extent, other physical resources (labs, library, transport) are insufficient, but efforts have been made recently to improve scientific and computer equipment.

In 1998, DASR national financial resources amounted to Syrian pound (SP) 240 million (around US\$ 5.2 million), mainly funded by the Government, of which SP 72 million were allocated to salaries/allowances (30%) and SP 168 million to operation and capital costs (OCC) (US\$ 3.7 million). External grants provided by diverse partners (see section on linkages), mainly allocated to OCC, are estimated at around US\$ 200,000 (around SP 10 million). OCC per graduate scientific member amounts to nearly US\$ 8,200, which is relatively low and inadequate for providing satisfactory conditions for research (see Section 4.3). Given the administrative status of DASR within MAAR, administrative procedures for mobilizing the financial resources are not flexible enough.

**Research Activities and Linkages** - DASR has 8 departments specialized in: field crops (cereals, maize, food legumes, oil crops, sugar beet, forage and pasture, agronomy, genetic resources), vegetables, horticulture (pomology, stone fruit, grapes, pistachio, date palm, medicinal and ornamental plants), plant protection, pesticides (herbicide testing, residual effects, etc.), livestock production (nutrition, breeding, etc.), food industries (dairy, food preservation, etc.), and socioeconomic studies (economic and social department, design/analysis/computer, library, training, etc.).

In the future, the weight of the field crops section (around 60% of the gsm) should decline (to 40%) in favor of the other sections, especially the livestock production section (which should receive 25–30% of the gsm, compared to 15% now), horticulture section (20% instead of 10%), plant protection section (20% instead of 10%), food industries section (5% instead of 2%), and socioeconomic studies section (5% instead of 1%). Higher attention will also be given to breeding and basic sciences (biotechnology, statistics/computer).

Collaboration with other national research and development institutions is rather good. Relations with the Faculties of Agriculture (Damascus, Aleppo, Lattakia, Deir Ez-Zor), which were focussed mainly on researchers' MS training, are now covering some research activities (forage/pasture, animal production, etc.) (see Section 4.2).

Cooperation with ICARDA and, to a lesser extent, with CIMMYT is already well developed (wheat, barley, lentil, chickpea, forage/pasture, sheep, natural resources, farming systems, socioeconomic) and is expected to grow. Linkages are significant with ACSAD (agronomy, cereal breeding, horticulture). Collaboration on biodiversity and genetic resources issues has recently started with IPGRI (which has researchers based at ICARDA, Aleppo) and the Global Environment Facility (GEF) program, funded by UNDP. Relations with bilateral agencies are currently very limited and should be developed in the future.

## The Directorate of Soils (DS)

**Mandate and Organization** - DS is responsible, within MAAR, for research on soils. Its senior staff allocates around 80% of its time to research and 20% to services (soil mapping, analysis), consultancies for development projects, training, etc. DS has its headquarters at Douma, Damascus, and 12 stations (one in each governorate). It has six

<sup>1</sup> pRYS = Number of researchers on duty × percentage of DASR resources allocated AR (80%).

<sup>2</sup> In 1988, 43% of the gsm (152 out of the 355 available) were located in or around Damascus. This percentage has dropped in 1998.

divisions (soil classification, land use, soil conservation, soil fertility and fertilization, microbiology, environment and meteorology), a geographic information systems (GIS) unit, and 13 laboratories (for soil, water and fertilizer analysis) at Douma and in the stations.

**Human, Physical and Financial Resources** - DS currently (1998) has 461 national permanent full-time staff, 161 of whom are graduate staff members (gsm), around 150 technicians and 149 other support staff.

The 161 gsm (10 PhD, 2 MS, 149 BS) represent around 129 pRYs. Their academic level is rather low and has hardly improved over the years<sup>1</sup>. Their past concentration at the headquarters has been reduced (61 gsm or 50% in 1988, 38% in 1998); however, only a few stations in the governorates have a good number of researchers (20 in Aleppo, 15 in Lattakia); most of the other ones are currently too small.

The numbers of technicians and support staff have largely increased within the last 10 years (24 technicians in 1988 for 120 gsm) and are now satisfactory.

Physical resources are considered insufficient, especially in terms of scientific equipment, computers and vehicles; however, efforts have been made to improve the facilities (offices, labs) during the last years.

DS national financial resources, funded by the Government, have significantly improved over the last 10 years<sup>2</sup> and currently (1998) amount to SP 115 million (US\$ 2.5 million), SP 25 million of which are for salaries/allowances and SP 90 million (US\$ 2 million) for OCC. External grants (1998), mostly allocated to OCC, are estimated at around SP 20 million (US\$ 0.4 million)<sup>3</sup>. Total OCC amounts to about US\$ 14,900 per graduate staff member, which is considered insufficient.

**Research Activities and Linkages** - DS currently has 12 gsm in the division of soil classification, responsible for soil surveys and maps; 11 gsm in the land use division (research on rotation, tillage, etc.); 15 gsm in the soil conservation division (water erosion, wind erosion, land reclamation); 35 gsm in the soil fertility and fertilization division (fertilization of crops and trees in rainfed and irrigated conditions); 12 gsm in the microbiology division (organic fertilization, microbiological treatment of wastes, Rhizobium, etc.); and 15 gsm in the environment and meteorology division. The recently established GIS unit employs 12 gsm. In the future, major attention will be given to the soil fertility/fertilization and soil conservation divisions, and to the GIS unit.

Collaboration is active mainly with DASR and DIWU at the national and governorate levels. It is limited with the faculties (some collaboration with the Faculty of Agriculture of Lattakia on water erosion).

International cooperation is well developed with ACSAD, mainly through the research project on desertification (in association with the Syrian General Organization of Remote Sensing, GORS), and with ICARDA (land use, fertilization of wheat and food legumes, wind erosion).

### **The Directorate of Irrigation and Water Use (DIWU)**

**Mandate and Organization** - DIWU has two main complementary responsibilities: one is research on irrigation, water use, and land reclamation at the field level (water requirements and irrigation systems for various crops, irrigation methods and technologies, reclamation of saline soils and drainage, water harvesting/spreading techniques, etc.), which mobilizes around 70% of its senior staffs time; the other is development support through studying and designing irrigation projects of MAAR. It has a central administration at Douma, Damascus, consisting of four divisions (research and studies, projects, management and maintenance, administration).

**Human, Physical and Financial Resources** - DIWU currently (1998) has 404 national permanent full-time staff, 125 of whom are graduate staff members, 86 technicians, and 193 other support staff.

The 125 gsm (5 PhD, 5 MS, 115 BS)<sup>4</sup> represent about 88 pRYs. Their current academic level is considered too low, and, until present, the possibilities for postgraduate training have been limited: only 2 MS holders are currently preparing a PhD abroad, while the need is for 3–5 PhD and 5–8 MS every year. The current geographic breakdown of the graduate staff members has improved over the years; their proportion has been decreasing at Douma and

<sup>1</sup> In 1983, DS had 169 gsm, including 11 PhD, 1 MS and 157 BS; in 1988, there were 120 gsm, including 6 PhD, 2 MS and 112 BS; and in 1993, out of 180 gsm, there were 6 PhD, 5 MS and 159 BS.

<sup>2</sup> In 1988, the DS budget amounted to SP 8.2 million, i.e., US\$ 1.4 million (US\$ 1 = SP 5.75 in 1988).

<sup>3</sup> These grants are coming from the Desertification Project (1994–2002), implemented with ACSAD (US\$ 0.8 million), with the participation of GORS (see Section 2.4) and the support of Germany (US\$ 1.9 million). An EU-supported project on salinity is starting (1999–2003; US\$ 0.14 million).

<sup>4</sup> Compared to 75 gsm in 1988 (2 PhD, 2 MS, 71 BS) and 125 gsm in 1993 (including 4 PhD).

increasing in the governorates<sup>1</sup>, and their geographic breakdown in the country is now satisfactory. However, the number of available graduate staff members is not sufficient to cover the needs, and only a few stations in the governorates have a sufficient number.

The ratios of technicians and other support staff to graduate staff member (0.7:1 and 1.5:1, respectively) are relatively low; however, the number of technicians has registered large growth in the last 10 years (15 in 1988, 21 in 1992).

DIWU has 11 stations, one in each governorate, which carry out research and service/development activities in the key agroecological zones. The current land resources are sufficient (total area: 120 ha, without counting the 30,000 ha of the research center of Mehasseh in the steppe and the 140 ha of the station of Rakka which will be soon opened). DIWU's other physical resources (offices; labs; library; scientific, computer, transport and communication equipment), funded by the Government and external agencies, are excellent.

In 1998, national financial resources funded by the Government amounted to SP 55 million (around US\$ 1.2 million), SP 13 million of which were allocated to salaries/allowances and SP 42 million to OCC. External grants in 1998 were exceptionally low (around US\$ 0.2 million from IDRC, ICARDA and Japan), much less than those received the previous years<sup>2</sup> which were mainly allocated to equipment. In 1998, OCC amounted to around US\$ 7,300 per graduate staff member. Future prospects are encouraging with higher government budgets (SP 72 million in 1999) and starting new projects funded by international agencies.

**Research Activities and Linkages** - Currently, 5 researchers are involved in the water harvesting and spreading research program implemented at the Mehasseh Center, and the 120 other gsm are allocated to the water requirements and supplementary irrigation program (almost 40%), the irrigation methods and techniques program (also almost 40%), and the drainage and salinity research program (around 20%). These programs are considered well balanced and will receive equal support in the next years.

DIWU has good relations with DASR and DS (see Section 4.1). Collaboration with external institutions (UNDP, IDRC, ICARDA, Japan) has been highly profitable and will be developed and diversified in the future.

#### **The Directorate of Cotton Bureau (DCB)**

DCB is a semi-autonomous agency under MAAR. Its headquarters are located in Aleppo, which is the geographic center of the cotton growing and ginning region in Syria. Its functions are to: (i) carry out research (mainly breeding) on cotton, alone or in collaboration with other national and foreign institutions; (ii) control the quality of the produced cotton; (iii) supervise the ginning and marketing of cotton; and (iv) help plan cotton production.

DCB has 62 permanent gsm (1 PhD, 2 MS, 59 BS, supported by 50 technicians)<sup>3</sup> involved in AR, 14 (2 MS, 12 BS) of whom are full-time researchers in breeding and 48 allocate equally their time to research (agronomy, plant protection, mechanization, etc.) and development activities. They represent 38 pRYs.

Research experiments are conducted in 9 well-endowed stations across the country as well as on farms (with close participation of farmers). The DCB total budget (1998) amounted to SP 130 million. Estimated research costs are SP 45 million (US\$ 1 million), of which SP 5 million were allocated to salaries and consultancies, and SP 40 million (US\$ 0.87 million) to OCC, i.e., around US\$ 23,000 per pRY.

The graduate staff members' low academic level is a constraint that DCB has almost completely overcome through the mobilization, in its research projects, of numerous highly qualified scientists (most of them PhD holders) from other NARS institutions (Faculty of Agriculture of Aleppo, DS, DIWU, General Organization of Mechanization, AECS, etc.) and through well-developed international linkages (mainly the efficient Mediterranean Cotton Research Network and ACSAD).

#### **The Central Directorate of Citrus Bureau (CDCB)**

CDCB was established in 1978 at Tartous. It is responsible for all research and development activities related to citrus production in Syria, except marketing. Its senior staff devotes 75% of its time to research and 25% to

<sup>1</sup> In 1988, there were 40 gsm at the headquarters and 35 in the governorates; in 1993, these numbers were 21 and 104, respectively.

<sup>2</sup> DIWU received US\$ 3.2 million in grants during the 1990s (US\$ 2.5 million from UNDP in 1990–97, US\$ 0.5 million from UNDP in 1992–1995, and 0.3 million from UNDP/IDRC in 1994–1999), in addition to the annual support coming from ICARDA (around US\$ 50,000/year), and the recent support from Japan for the activities developed at the Mehasseh Center.

<sup>3</sup> Compared to 33 researchers (2 PhD, 1 MS, 30 BS) and 25 technicians in 1988.

development activities. Its AR activities cover tissue culture, biological control, fertilization, varieties and plant protection.

It has 44 gsm (1 MS, 43 BS), with 20 gsm at the headquarters and 24 BS holders working in the 6 CDCB sections, one in each governorate, where citrus research and services are needed. This staff, whose low academic level is considered a major constraint, represents 33 pRys.

CDCB national financial resources are around SP 12 million (US\$ 0.26 million) (1998), of which SP 5.4 million are for salaries/allowances and about SP 6.6 million for OCC (SP 150,000 or US\$ 3,300 per gsm). External grants (US\$ 500,000) were reported as coming only from FAO during 1994–96 to cover mainly OCC for a biological control project on citrus.

CDCB has active collaboration with the facilities of agriculture in Syria, DS, Directorate of Extension, DASR and AECs. Regional cooperation with AOAD takes place through training courses.

### **The Central Directorate of Olive Bureau (CDOB)**

CDOB was established in 1980 in Idleb to assume the overall responsibility for olive production and development in Syria. It has 5 divisions (multiplication, protection, milling and processing, training and extension, planning and studies) and 10 sub-directorates (one in each governorate). Research mobilizes around 70% of its senior staff's time; the remaining 30% are allocated to development and other services.

CDOB currently (1998) has 66 national permanent full-time staff members, 40 (1 PhD, 3 Diploma, 36 BS) of whom are gsm, representing around 20 pRys, and 6 technicians.

Physical resources are satisfactory, but scientific equipment is insufficient, especially for analysis and for the biological control laboratory, despite recent efforts for improvement.

In 1998, the national budget was SP 12 million (US\$ 0.26 million), of which SP 4 million were allocated to salaries and allowances and SP 8 million to OCC (US\$ 6,200 per graduate staff member). External grants in 1998 from FAO amounted to US\$ 320,000 (SP 15 million).

Collaboration is active with the faculties of agriculture, DASR, and DS. International cooperation is well developed with FAO, ICARDA, and the International Council for Olive Oil.

### **The Marine Research Institute (MRI), University of Tishreen**

MRI was created in 1987 and is affiliated to the University of Tishreen, Latakia. Its scientific graduate staff equally distributes its time between research and teaching/training. MRI offers postgraduate education (Diploma, MS, PhD) in marine sciences.

MRI currently (1998) has 14 scientists on duty (14 PhD), who represent 7 pRys, supported by 16 staff members (technicians, clerks, etc.), and 14 MS holders abroad preparing PhD degrees. MRI scientists enjoy the same incentives and conditions as university staff.

MRI has 5 departments: marine chemistry, marine biology, marine physics, marine geology, and marine fisheries and vertebrates. Its research mandate covers physical and chemical properties of seawater, sea currents and tides, marine organisms, climatic conditions, marine pollution and its effects, and desalination of seawater. Priority in research is given to marine biology and chemistry.

Physical resources are good but insufficient and need more improvement. MRI has an experimental station for research purposes (marine culture).

The national budget funded by the Government amounts to SP 10 million of which SP 2 million are for salaries and SP 8 million for OCC (SP 570,000 or US\$ 12,400 per scientist on duty). External funding (without the fellowships) is very limited.

MRI has good relations with national institutions of the Ministry of Agriculture (research in fisheries), universities (marine ecology), Ministry of Environmental Affairs (marine and coastal ecology), and Ministries of Oil and Irrigation (hydrology studies). It also has relations with the Center of Studies and Scientific Research, the Atomic Energy Commission, and GORS.

On the international level, MRI cooperates with UNEP (environment project), FAO, World Health Organization (WHO), and the International Atomic Energy Agency (IAEA).

## **2.3 The Faculties of Agricultural Sciences**

## Overview

The six Faculties of Agricultural Sciences (FASs) are (see [Table 1](#)):

- the Faculty of Agriculture (FA), University of Damascus, the oldest and largest university, with 231 academic/graduate staff members (asm), including 136 PhD and 30 MS holders, and 65 engineers (BS); and 75 technician (1998/99);
- the FA, University of Aleppo, with 213 asm, including 158 PhD and 30 MS holders, 25 of whom are preparing PhD degrees abroad, and 25 BS; and 40 technicians;
- the FA, University of Tishreen/Lattakia, with 197 asm (122 PhD, 5 MS, 70 BS);
- the FA, Baath University of Homs, with 43 asm (30 PhD, 13 BS);
- the FA of Deir Ez-Zor, University of Aleppo, with 75 asm (60 PhD, 15 BS); and
- the Faculty of Veterinary Medicine of Hama, University of Homs, with 77 asm (65 PhD, and 12 MS and BS).

**Mandate and Organization** - The FASs are semi-autonomous within their universities which are affiliated to the Ministry of Higher Education. The main activity of the FASs is teaching: all grant BS degrees (5 years<sup>1</sup>); the FA of Lattakia also offers Diploma (1 year after BS, in addition to a graduation project) and MS degree programs, and the FAs of Damascus and Aleppo grant MS and PhD degrees. The BS, MS and PhD programs have the same standardized national curriculum designed by the Higher University Council.

The FASs consist of departments that are more or less balanced<sup>2</sup>. The number of students enrolled at the FASs has dramatically increased during the 1970s and 80s, but has now stabilized or is even decreasing because of the labor market limitations on agricultural graduates; however, the ratio of students to academic staff is still rather high<sup>3</sup>.

**Human, Physical and Financial Resources** - The six FASs have 1033 asm, including 571 PhD and 71 MS holders, who are academic staff members, and 391 Diploma and BS holders considered as "technical support staff," actually working as technicians (about 250 for the six FASs). The academic staff members of the FASs represent the large majority of the highest qualified staff of the NARS. This resulted from the 1977 decree which raised the salaries of all university faculty to 200% of the standard public sector base salary rates to compensate for the increase of the course loads.

Every FAS has one or two farms for demonstration/training and for production<sup>4</sup>. Physical facilities are generally inadequate both in quantity and quality; buildings, classrooms and labs are more or less overcrowded; laboratory equipment, computer facilities, machinery, vehicles, etc. are generally insufficient or obsolete; and libraries are not able to adequately serve the training and research needs. Resources are actually providing only the basic needs.

The FASs have no financial autonomy. Their national financial resources are provided mostly by their universities (essentially government-funded) according to the available budgets and needs, and roughly amount to SP 250 million (around US\$ 5.5 million), more or less equally allocated to salaries and OCC<sup>5</sup>. External grants allocated to OCC (without taking into consideration the fellowships for postgraduate studies abroad) are very limited (no more

<sup>1</sup> Two years of education in basic sciences (most often with the support of academic staff from the Faculty of Sciences), then 3 years of specialized education; the fifth year is devoted mainly to the preparation of a "graduate project."

<sup>2</sup> For example, there are 10 departments at the FA of Damascus: basic sciences (8 asm in 1997/98), soil sciences and land reclamation (13), field crops (7), horticulture (13), forestry and ecology (10), plant protection (20), animal production (20), food sciences (17), agricultural engineering (6), agricultural economics (10); 8 departments at the FA of Aleppo (soil sciences, forestry ecology, field crops, horticulture, crop protection, animal production, food sciences, rural economics); 4 departments at the FA of Homs.

<sup>3</sup> For example, the FA of Damascus currently (1998/99) has more than 1,800 students (of whom 12, 35 and 175 are preparing PhD and MS degrees and Diploma, respectively); Aleppo has 1,650 students (of whom 9, 31 and 106 are preparing PhD and MS degrees and Diploma, respectively), compared to 1,500 students in 1993 and up to 2,500 students at the end of the 1970s.

<sup>4</sup> For example, the FA of Damascus has a farm of 75 ha 18 km from the capital; the FA of Aleppo has a farm of 134 ha 22 km from the city.

<sup>5</sup> Estimate based on data provided by the FA of Homs (1998 government budget: SP 5.5 million for salaries and around SP 5 million for OCC).



than US\$ 200,000). The total available OCC (around SP 130,000 or US\$ 2,800 per academic staff member) is insufficient and mainly allocated to training activities. Lengthy administrative procedures hamper timely availability of supplies and materials.

**Linkages with Scientific Institutions** - Scientific coordination among the FASs and linkages with the national AR and scientific institutes and extension services are moderate and informal. International cooperation (either with regional/international or foreign scientific institutions, or with funding agencies) is rather limited, except for the FAS of Damascus (AUPELF/UREF) and Aleppo (ICARDA, Hohenheim University and IDRC), ICARDA being the major cooperating institution.

### **Research at the Faculties**

AR at the FASs currently suffers from a number of major constraints and limitations, mainly:

- The lack of research policy of the FASs and rather weak linkages with the national AR institutes.
- The limited time available for the academic staff members to carry out research activities due to the heavy teaching loads induced by the relatively high number of students (more than 10 students per asm) and the "necessity," due to the low salaries, to seek other activities/sources of income (mostly consultancies).
- Inadequate research resources, reflecting the resource limitations presented above (insufficient physical facilities; limited and variable national and external funds available for research).

Accordingly:

- AR is currently carried out mainly by young academic staff members and graduate students, and the objectives of their research projects are largely identified and chosen on a personal-interest basis and rarely according to the priority needs of the agricultural sector.
- The percentage of human and financial resources actually allocated to AR activities is rather low. For example, the FAS of Damascus, Aleppo and Lattakia consider that their academic staff members allocate around 10 to 15% of their time to AR; the staff members of the other FASs are even less involved or hardly conduct any AR at present. It appears realistic to consider that the FAS academic staff members dedicate (as an average) around 10% of their time to AR, which means that the six FASs represent around 100 actual RYs instead of the 203 normative potential RYs.

However, the situation has been improving over the last years. Research at the FASs is now recognized as a mandate as important as education, and incentives exist for the academic staff to dedicate time to this activity. Since the mid-1990s, progress in the academic staff members' careers through evaluation of their education and research performance depends highly on their engagement in research and on their publications; since 1997 a financial "reward" of SP 5,000 is being offered for every scientific paper approved and published<sup>1</sup>.

## **2.4 The Other Scientific Institutions of the NARS**

### **The Department of Radio-agriculture of the Atomic Energy Commission of Syria (AECS)**

This Department is the largest within AECS; it mobilizes around 25% of the total resources of the Commission. It currently employs 21 researchers on duty (12 PhD, 2 MS, 7 BS) involved full-time in research, and another 7 young researchers now on study leaves abroad (preparing PhD). It has a rather low number of technicians (8 "low" Diploma holders), but enjoys good physical resources (labs at Damascus and a small animal research station near the capital) and satisfactory government financial support.

Its AR activities cover biotechnology applied to breeding, agronomy (soil and water salinity, crop resistance to saline soil), entomology (integrated pest management through sterile insects), animal production (breeding, physiology), and food preservation. Biotechnology and food preservation will be reinforced in the future.

It has developed relations with national institutions (mainly the FA of Damascus, DASR and DS), ICARDA and ACSAD. It also has a good number of collaborative programs with IAEA/Vienna, the Arab Atomic Energy Agency (AAEA), and with scientific institutions in India, the UK, Poland and Russia.

### **The General Organization of Remote Sensing (GORS)**

<sup>1</sup> The trimestrial scientific review, "Bassel Al-Assad," published by the FA of Damascus, has a long waiting list of papers prepared by scientists from all the FASs and other national institutions ready for publication after approval by its scientific committee.

GORS is responsible for research and development activities related with remote sensing applied to geology, geophysics, hydrology, the environment and agriculture. It allocates around 10% of its resources<sup>1</sup> to AR activities, which mobilize (1998) around 13 pRYs<sup>2</sup> and SP 10 million (US\$ 0.2 million).

Physical resources are excellent (large and modern facilities and equipment near Damascus) and funds mainly provided by the Government cover the basic needs. Until present, AR activities have received few external grants.

AR-related activities consist mainly of survey/mapping of natural resources (monitoring and evaluating land resources, soil potentialities, soil erosion, desertification in the steppe, groundwater, etc.). Most of these studies have been implemented in full collaboration with other NARS institutions (FA of Damascus, DASR, DS, DIWU, DCB, etc.) and with ICARDA and ACSAD. GORS is making efforts to develop relations with foreign similar institutions (France, Germany, etc.).

### **The Environmental and Scientific Research Center (ESRC)**

ESRC is responsible for research and development activities related to environmental affairs in Syria. AR-related activities<sup>3</sup> represent about 25% of its total resources<sup>4</sup>.

AR-related activities mobilize 10 full-time researchers (2 PhD and 8 BS), who are involved in natural protected areas and soil and water management (salinity, polluted water, etc.) issues. National funds allocated to these activities amount (1998) to around SP 70 million (US\$ 1.5 million), and are complemented by grants from Germany (about US\$ 0.2 million in 1998). National and international linkages are insufficient and need to be developed.

### **The Other Faculties (Sciences, Civil Engineering, Economics, etc.)**

Some Faculties of Sciences, Civil Engineering<sup>5</sup>, and Economics may include a relatively large number of staff members highly qualified in AR-related scientific fields (natural resources, irrigation, plant and animal biology, oceanography and fisheries, agricultural engineering, food processing, agricultural social sciences). A precise inventory of this potential is not available, but it may reach around 200 academic staff members (rough/provisional estimate), representing around 50 pRYs. Under the assumption that 10% of this potential is actually mobilized for research (as for the FASs), there would be no more than 20 actual RYs instead of the 50 normative potential RYs.

## **2.5 The Agricultural Development/Service Bodies Involved in AR**

### **The Other MAAR Directorates Partly Involved in AR**

Some directorates are implementing significant AR activities, among them are: the Directorate of Steppe, the Central Directorate (CD) of Mechanization recently renamed the General Organization of Mechanization, the CD of Agricultural Economics, and the CD of Planning and Statistics<sup>6</sup>.

The Directorate of Steppe, Palmyra - This Directorate established together with the Directorate of Agriculture of Hama, the Al-Kram Center for Sheep Breeding located near Salamieh, Hama. This Center is implementing applied

<sup>1</sup> 325 permanent staff members, including 121 gsm (12 PhD, 2 MS, 107 Diploma and BS); total national budget: around SP 90 million (US\$ 2 million).

<sup>2</sup> This is calculated from: (i) 10 gsm (3 PhD, 1 MS, 6 BS) with a background in agricultural sciences, who are working full-time within the Agricultural Studies and Agricultural Applications Offices (respectively under the Directorate of Applications and Projects and the Directorate of Field Studies); and (ii) the equivalent of around 3 pRYs coming from BS holders from other Directorates who provide technical support in information processing, surveys and aerial photography.

<sup>3</sup> Other activities are related with climate changes, air pollution, energy/industry/transport pollution, solid waste management, trace metals in food commodities, etc.

<sup>4</sup> 60 permanent graduate staff members, 15 technicians, and 41 administrative employees (including 11 graduate employees); total national budget: SP 300 million (US\$ 6.5 million), of which around SP 30 million are for salaries/allowances and SP 270 million for OCC (more than US\$ 200,000 per gsm, which is very high), mainly allocated to procuring new equipment and to establishing a large new center which will be opened in 2001.

<sup>5</sup> For example, the four Faculties of Civil Engineering of Aleppo, Damascus, Homs and Lattakia have sections specialized in irrigation, two of them collaborate with DIWU; other sections are concerned with environmental affairs.

<sup>6</sup> Other directorates may be marginally involved in AR activities (CDs of Plant Protection, Damascus; Forestry, Damascus; Fisheries, Jableh; etc.); however, a precise inventory of their activities and the concerned resources is not currently available.

research on sheep breeding, reproduction and production. It has 6 graduate staff members (1 PhD, 5 BS) and 6 technicians. Its 1998 national budget amounted to SP 5 million. It has close relations with ACSAD<sup>1</sup>.

**The General Organization of Mechanization (GOM, Aleppo)** - GOM was established in 1977 to carry out research, training and services for farmers. It has 21 gsm (1 PhD, 20 BS), of whom 6 are at the headquarters in Aleppo and the remaining in the other governorates where GOM has some workshops and experimental stations. Forty percent of the graduate staff members' time is allocated to research (currently focussed on cotton, sugar beet and potato mechanization) implemented in collaboration with national institutions (Cotton Bureau, DASR, CD of Extension, etc.) and with ICARDA (lentil, chickpea mechanization). Out of a total budget of SP 85 million, around 10 are allocated to research and the balance to farmers' services (maintenance and repair of agricultural machinery).

**The Central Directorates of Agricultural Economics and Planning/Statistics, Damascus** - These two CD's employ 11 graduate staff members (2 PhD, 1 MS, 8 BS) who are involved in research, studies and surveys in the field of agricultural economics related with land use and production, producer and input prices, investment policies, marketing, trade policies and farm income and employment. 50% of their activities could be considered as research.

All these directorates meet around 20 pRys and may mobilize (rough estimate) some SP 10 million for research.

### **The Public Agro-industrial Enterprises**

These enterprises are the General Organization for Tobacco (GOT) and the General Organization for Sugar (GOS). Precise data are not available; however, as a rough estimate, they employ around 40 graduate staff members in their research units<sup>2</sup>.

## **3. AR RESOURCES**

### **3.1 Human Resources** (see Table 1)

Almost 3,000 graduate staff members (all national) are working in the Syrian NARS and represent around 1058 pRys. The AR institutions and the FASs account for around 31 and 34% of this total, respectively.

Among these two large categories of institutions, the large difference in the academic level of their graduate staff is worth noting: the FASs have the largest number and proportion of the highest trained scientists (571 PhD holders, i.e., 55% of the academic staff, and 88% of the PhD holders of the two categories of institutions), while the AR institutions have only 78 PhD holders (8% of the graduate staff) and consider the low academic level of their graduate staff members as their main constraint. This difference may be explained by the much higher salaries/allowances received by the academic staff. However, during the last few years, the Government has taken measures to minimize or reduce these differences, which include improving the academic qualifications of the staff of the AR institutions and increasing the salaries and benefits to be commensurate with qualifications (academic degree) and achievements<sup>3</sup>. However, salaries in all the NARS institutions are considered low compared to those in the private sector, and most of the staff have to seek other sources of income.

The concentration of graduate staff in/around Damascus which prevailed two decades ago has been considerably lowered, and the NARS institutions now cover the country rather well according to the importance of agriculture in the different regions. However, in the AR directorates, the graduate staff is split into too many stations; this situation is favorable for extension activities but not for research which needs smaller numbers of locations that are well equipped with human and physical resources.

Most of the NARS institutions suffer a large deficit in technicians, which may considerably reduce the efficiency of the scientists.

<sup>1</sup> The Center received from 1992 to 1995 a US\$ 125,000 grant for research/development work on sheep production with farmers' participation.

<sup>2</sup> In 1984, GOT had 19 researchers (2 PhD, 17 BS) and GOS 10 researchers (all BS).

<sup>3</sup> During the last years, the difference in salaries between researchers within MAAR (DASR, DIWU, DS) and academic staff members of the faculties has been narrowed. In 1993, the monthly salary for PhD holders with 10 years' experience at the AR institutions amounted to around SL 4,000 (US\$ 90) with some additional "incentives" (e.g., SL 15,000 at the completion of a research task) at DASR, and SL 10,000 at the faculties. Currently, this average monthly salary (including allowances) at the AR institutions amounts to around SP 12,000 (US\$ 260) for a PhD holder and SP 9,000 (US\$ 200) for a BS holder. These figures are 20% less than at the universities.

### 3.2 Physical Resources

Land resources (research stations, farms) of the NARS institutions cover most of the agroecological zones and are considered satisfactory by most of the NARS institutions. With a few exceptions, facilities (offices, farm buildings) are sufficient, but scientific equipment, computer, vehicles, communication equipment) as well as libraries and documentation services are considered rather inadequate.

Given the large number of NARS institutions, there are too many locations (headquarters, experimental farms, etc.) which should be reduced in order to meet the needed human and physical resources and to make better use of the financial resources.

### 3.3 Financial Resources (see Table 1)

In 1998, the total financial resources allocated to AR in Syria were estimated at around SP 705 million (US\$ 15.3 million), of which SP 630 million (US\$ 13.7 million) came from national sources (mainly the public budget of the ministries concerned), and SP 75 million (US\$ 1.6 million) from external funds essentially secured through bilateral or multilateral grants provided by a few donors.

The NARS national and total resources amounted to around 0.28 and 0.31%, respectively, of the AGDP (estimated at US\$ 4.9 billion in 1996). Such ratios are much under the 1% ratio recommended by some international organizations (World Bank, European Union, etc.).

Areas of expenditure vary between the NARS institutions; however, at all the directorates involved mainly in AR, except DCB, the available OCC per graduate staff member is relatively low and inadequate for allowing satisfactory conditions of work (US\$ 8,200 at DASR; 14,900 at DS; 7,300 at DIWU; 6,200 at CDOB; etc.). The corresponding OCCs per pRY, which are slightly higher<sup>1</sup>, are much under the "optimal" amount of US\$ 25,000–30,000 per RY used in the long-term plans drawn up by many developing countries, which means that the AR scientific potential is currently far from being fully mobilized. According to this reference, the actual scientific potential of all these directorates is approximately 285 actual RYs (of which around 125 are at DASR, 80 at DS, etc.) instead of 694 pRYs (see Table 1).

As seen above, the FASs may contribute to the NARS around 100 aRYs. At the other scientific institutions (MRI, AECS, GORS, ESRC), and certainly at the public enterprises (GOT, GOS), the financial situation is much better than at the AR directorates, and their aRYs may be only slightly lower than their pRYs.

Therefore, the Syrian NARS may have around 500 aRYs (rough estimate) as opposed to the 1058 pRYs estimated above, which means that its human potential is much underemployed.

Since most of the NARS institutions (directorates, faculties) are not autonomous administrative units, they suffer lack of flexibility and responsibility in the management of their financial resources.

## 4. RESEARCH ACTIVITIES

### 4.1 Research Orientation

Because a precise national inventory of the AR programs and a national AR plan are not available, it is difficult to present a full balance of the research activities. Until present, priority has been given to applied disciplinary research, especially for field crops, horticulture (vegetables and fruit), and natural resources (soil and water); other domains such as animal production and agricultural economics have been more or less neglected.

Recently, attention has been given to "modern" sciences (biotechnology, remote sensing, isotopes, computers) at the NARS institutions endowed with highly qualified scientists. DASR is also implementing an interdisciplinary approach within farming systems research.

A national AR master plan to guide efforts for a better balance between research programs implemented by the NARS institutions is still lacking.

<sup>1</sup> As the numbers of pRYs are lower than the number of graduate staff members, and part of the OCCs are allocated to other activities than research (see Table 1). The estimated OCC per RY amount to around US\$ 9,200 at DASR; 16,800 at DS; 8,900 at DIWU, etc. (the most favorable is US\$ 23,000 at DCB).

#### 4.2 National and International Linkages

Relations between the main AR directorates (DASR, DS, DIWU) are good, thanks to their complementarity and the proximity of their headquarters. Most of the other directorates seem rather isolated, except DCB which implements research programs associating the best scientists from other institutions. To date, the FASs have had a marginal place in the NARS, but their relations with the research directorates and other scientific institutions are increasing.

The directorates involved in AR generally have good relations with development bodies and organizations; this is the main advantage of their current status as directorates.

It is well recognized that AR has contributed significantly (along with other national public services and public and private organizations) to national agricultural development which has been rather good over the last 10 years; the AGDP has registered a 50% growth during the period 1985–95. The impact of AR has been important in some areas such as field crops (cereals, food legumes, fruit, etc.) and cotton (Syria has the highest yields in the world).

International cooperation has been rather limited so far, except with ICARDA and ACSAD which have developed strong linkages with the main institutions that have mandates related to theirs. Relations have been recently developed with other international AR centers (CIMMYT, IPGRI, IWMI, etc.). In the future, scientific cooperation is planned to be extended to neighboring and developed countries.

#### 5. CONCLUSION

The Syrian NARS has been rather dynamic during the past years. The major achievements have been the growth of the human, physical and financial resources of the MAAR Directorates involved in AR, the consolidation of the highly qualified academic staff at the FASs, the creation of new institutions (FA, Homs; GORS; ESRC); striving for better regionalization of research efforts within the country; and establishing efficient linkages with development bodies (at least for the MAAR Directorates).

However, the NARS is still suffering strong weaknesses. It remains highly fragmented, and coordination between the two main sets of institutions represented by the MAAR Directorates and the FASs is weak and does not take advantage of their complementary characteristics (support staff, physical and financial resources in the directorates; qualified staff in the FASs). Financial resources allocated to AR are relatively limited with regard to the size of the country and the challenging long-term food prospects resulting from the growing population and limited natural resources. Financial resources are not optimally used because of the absence of mechanisms for setting priorities, planning, monitoring and evaluation of research activities in most of the institutions and at the national level; and the excessively large number of infrastructures and experimental stations.

#### Main Acronyms

**MAAR:** Ministry of Agriculture and Agrarian Reform. **MHE:** Ministry of Higher Education.

**DASR:** Directorate of Agricultural Scientific Research. **DCB:** Directorate of Cotton Bureau. **DIWU:** Directorate of Irrigation and Water Use. **DS:** Directorate of Soils. **AECS:** Atomic Energy Commission of Syria. **GORS:** General Organization of Remote Sensing. **ESRC:** Environmental and Scientific Research Center.

**LS:** Syrian pound

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Table 1 - The National Agricultural Research System (1998)

Indices: Approximate data or rough estimate. \*: Rounded numbers. .... Data not available. \*\*: See footnotes.

NARS Institutions				Scientific & Tech. Graduate Staff* Total - (PhD, MS)	Potential Research Years*	Total Budget (million SP)		AR Expend/Res. (E) (million US\$)				
No.	Name - Acronym Head Office - Year Established	Mandate AR Fields	Govern. Minist.			NE NE	RE RE	TE TE				
a	b	c	d	e	f	g	h	i	j	k	l	
1.1	Directorate of Agric. Scientific Research - Damascus	DASR - 1965	AR (80%) - (AD) All (see sect. 2.2)	MAAR	473	47, 70	378	240	10	215	10	235
2.1	Directorate of Soils - Damascus	DS - 1970	AR (80%) - (AD) Soils	MAAR	181	10, 2	129	115	20*	105	20	125
2.2	Directorate of Irrigation and Water Use - Damascus	DIWU - 1987	AR (70%) - (AD) Irrigation	MAAR	125	5, 5	88	55	10*	45	10	55
2.3	Directorate of Cotton Research - Aleppo	DCR - 1952	AR (60%) - (AD) Cotton	MAAR	62	1, 2	38	130		15		45
2.4	Central Directorate of Citrus Research - Tartous	CDCR - 1978	AR (75%) - (AD) Citrus	MAAR	44	0, 1	33	12	10			10
2.5	Central Directorate of Olive Research - Latakia	CDOB - 1980	AR (70%) - (AD) Olive	MAAR	46	1, 3	28	12	15	10	15	25
2.6	Marine Research Institute, Tartous Univ. - Latakia	MRI - 1987	AHE - AR: 50% Marine sciences	MHE	28	14, 14*	7	18	-	5	-	5
1.2	Total AR Institutes				933	78, 97	701	582	55	435	55	490
3.1	Faculty of Agriculture - Damascus	FA/D - 1960	AHE - (AR) All	MHE	231	136, 30	46	250	10	25	10	35
3.2	Faculty of Agriculture - Aleppo	FA/A - 1960	AHE - (AR) All	MHE	213	158, 30	47					
3.3	Faculty of Agriculture - Latakia	FA/L - 1971	AHE - (AR) All	MHE	197	122, 5	49					
3.4	Faculty of Agriculture - Hama	FA/H - 1994	AHE - (AR) All	MHE	43	30, 0	11					
3.5	Faculty of Agriculture - Dar El-Zor	FA/D - 1977	AHE - (AR) All	MHE	75	60, 0	1*					
3.6	Faculty of Veterinary Medicine - Hama	FVMH - 1969	AHE - (AR) Animal health/prod.	MHE	77	64, 8	19					
3	Total Agricultural Sciences Faculties				1033	571, 71	203	250	10	25	10	35
4.1	Dep. of Radio-agr., Atomic Energy Com. - Damascus*	AECR - 1979	AR: 100%*	PM	21	12, 2	21	15	...	15	...	15
4.2	Ag. Office, Gen. Org. for Remote Sensing - Damascus*	GORS - 1986	AR: 100%*	PM	43	3, 1	19	11	...	10	...	10
4.3	Ag. Sect., Environ. & Scen. Res. Center - Damascus*	ESRC - 1994	AR: 100%*	MRA	10	2, 0	1*	70	10	10	10	50
4.4	Frontiers of Sciences, Civil Eng., Economics, etc.*		AHE + R (AR) Diverse	MHE	209	120, 20*	50	...	...	5	...	5
4	Total Other Scientific Institutions				244	137, 24	60	...	...	100	10	490
5.1	Other MAAR Directorates (see Section 2.5)		AD - (AR) Diverse	MAAR	40	4, 1	20	...	...	15	...	15
5.2	Agro-indus. Enterprises (Tobacco, Sugar) (see Sec. 2.5)		(AD - (AR) Tobacco, sugar	MAAR	44	...	1*	...	...	50	...	50
5	Total AR in Admin/Development/Service Bodies				89	...	60	...	...	60	...	70
6	Total NARS				2290	...	1055	...	...	630	75	705
Exchange Rate: US\$ 1 = Syrian pound (SP) +6 (1998 average rate)					Actual Res. Years (ARY) (estimate) =>		500	AR Expenditures (million US\$) =>		13.7	1.6	15.3

MAAR: Ministry of Agriculture and Agrarian Reform; MHE: Ministry of Higher Education; MRA: Ministry of Environmental Affairs; PM: Prime Minister.

c. Mandates: AR: % Ag. research; R: Research; AHE: Ag. higher education; AD: Ag. development/services (for AR and AHE institutes, seed production, soil and water analysis, extension, studies, etc.); g. Potential research year (pRY) = equivalent full-time researcher; for the FASS, the pRYs were estimated by multiplying the number of academic staff by 0.25; j. For the AR institutes, AR financial resources were roughly estimated through the following formula: Total budget  $\times [a + 0.5(100 - a)]$ , a being the % of time devoted to AR by the graduate staff.

\* Notes: All the graduate staff members and pRYs are national. 2.46% The 14 MS holders are preparing PhD degrees abroad. 3.26% 23 MS holders are preparing PhD degrees abroad. 4.1 to 4.4: Only the human and financial resources allocated to AR are mentioned.

National AR expenditures (NE): 0.28% of the Agricultural Gross Domestic Product (AGDP: US\$ 4.9 billion in 1996). Total AR expenditures (TE): 0.31% of the AGDP.

## **7. MONOGRAPHS OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEMS OF THE HIGHLANDS REGION**

**IRAN**

**TURKEY**





## THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF IRAN<sup>1</sup>

### 1. HISTORICAL BACKGROUND

Agricultural Research (AR) in Iran dates back to 1925 when the Razi Institute, the "father" of the current Razi Serum and Vaccine Research and Production Institute (RSVRI), began its research activity in the district of Karaj, about 35 km west of Tehran, by conducting research projects on the production of animal vaccines and the eradication of the contagious cattle plague disease, which had threatened the cattle population of the country. The next year (1926), the first agricultural college, affiliated to the Ministry of Agriculture (MOA), was founded in Karaj. In 1933, the first college of veterinary medicine was opened in Tehran. Three AR institutes were soon founded: the Livestock and Animal Sciences Institute (Karaj, 1933, called later the Animal Husbandry Research Institute, then the Animal Sciences Research Institute: ASRI), the Sugar Beet Seed Institute (Karaj, 1937, currently the Sugar Beet Research Institute: SBRI), and the Iranian Tobacco Center (Tirash, 1937).

Important changes occurred in the 1950s and 60s. In 1955, the two existing colleges of agriculture and veterinary medicine were transferred to the University of Tehran, and four other colleges of agriculture (Ahwaz, Shiraz, Tabriz and Urumia), followed by another one in 1956 (Ramin/Ahwaz), were created within newly established universities. New AR institutes were created with technical support from international agencies, such as FAO, mainly:

- The Seed and Plant Improvement Institute in Karaj (SPII, 1959) for research and seed multiplication in the main crops (cereals, oil crops, cotton, rice, horticulture, forages, etc.)
- The Directorate General of Pest Control, established in 1943 under MOA in Tehran, was changed to the Plant Pests and Diseases Research Institute in 1962. The mandate of the Institute includes: (i) collection, identification and preservation of harmful agents to plants, together with their host plants; (ii) study of biology and ecology of plant pests, pathogenic agents and weeds and their control; and (iii) evaluation of new pesticides.
- The Soil Institute of Iran was established in 1966 in Tehran with the amalgamation of the General Directorate of Soil Fertility (within MOA) and the Soil Survey Division of the independent Irrigation Authority, with the mandate of conducting research and field studies on soil classification and land suitability evaluation, soil fertility and plant nutrition, irrigation, soil chemistry and biology, and land reclamation.
- The Research Institute of Natural Resources, established in 1967 in Tehran, within the Ministry of Natural Resources, with a wide range of activities (soil, range, forestry, wild life, fisheries), renamed as the Forest and Rangeland Research Institute (FRRI) under MOA.
- The Botanical Garden, Tehran (1968, merged in 1980 with FRRI).

With the ratification of a new Act by the Iranian Parliament in 1961, most of the existing agricultural institutes were officially established under MOA and kept their autonomy, with their own facilities and research projects in the different zones of the country, with very few joint activities. The groundwork for the establishment of a coordinated AR unit within MOA was laid in 1975 with the establishment of the Agricultural and Natural Resources Research Organization (ANRRO) as a separate entity, headed by the Deputy Minister of Agriculture, to formulate policies and make decisions on research priorities and to coordinate the activities of the AR institutes. Then, in 1982, a Central AR Council was created as the highest coordinating and decision-making body, chaired by the Deputy Minister of Agriculture with the participation of directors of the existing research institutes.

After the revolution, the NARS greatly evolved. Some new institutes (the Agricultural Economics Research Bureau: AERB, Tehran, 1985; the Agricultural Engineering Research Institute: AERI, Karaj, 1988) were created.

Two major changes were registered in the last decade:

- In 1990, the newly founded Ministry of Jihad Construction (MOJC) took over from MOA the AR institutes related to forest, range and animal sciences (FRRI, RSVRI, ASRI), and created the Fisheries Research and Training Institute (FRTI, Tehran, 1990) and the Soil Conservation and Watershed Management Research Institute (SCWMRI, Karaj, 1993).

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- Within MOA, ANRRO kept the crop-related research institutes and was merged with the Agricultural Education and Extension Directorate leading to the formation of the Agricultural Research, Education and Extension Organization (AREEO) in 1993. Since then, new research institutes were founded to unload the Seed and Plant Improvement Institute in Karaj (SPII) from its heavy responsibilities, to implement extensive research on some of the major commodities and non-commodity items of economic importance, and to have a more focused research plan with a multidisciplinary approach. These are the Dryland Agricultural Research Institute (DARI, Maragheh, 1991), the Pistachio Research Institute (PRI, Rafsanjan, 1992), the Citrus Research Institute (CRI, Ramsar, 1992), the Rice Research Institute (RRI, Rasht, 1993), the Date palm Research Institute (DRI, Ahwaz, 1994), and the Cotton Research Institute (CRI, Gorgan, 1996).

Simultaneously, the number of colleges of agriculture was growing rapidly: 2 during the 1960s, 8 during the 1970s, and 5 new ones since 1980. At present, there are more than 20 agricultural colleges (and many junior colleges) spread throughout the country, which are affiliated to different universities of the Ministry of Culture and Higher Education (MOCHE). In addition, there are many senior and junior colleges affiliated to the Free Islamic University, which are spread throughout the country.

## 2. THE CURRENT NARS

### 2.1 Overview (see Table 1)

The Iranian NARS currently includes a large number of scientific and technical institutions within different ministries; they may be grouped into two main categories:

- The institutions mainly involved in AR: the 12 AR institutes (ARIs) under the governance of the Agricultural Research, Education and Extension Organization (AREEO, MOA); the 7 ARIs under MOJC; and some other small ARIs, affiliated to MOA, MOCHE and the Ministry of Health (MOH); they account for 87% of the potential research years (pRYs or equivalent full-time researchers) and 93% of the total financial resources of the NARS. These institutions are presented in Section 2.2.
- The 19 colleges of agriculture and 5 colleges of veterinary medicine affiliated to MOCHE: they meet around 11% of the pRYs and 5% of the financial resources of the NARS (see Section 2.3).

A few other institutions (scientific institutions and public industrial companies), in which AR activities cover a more or less small part of their mandate, meet the marginal remaining resources of the NARS (see Section 2.4).

NARS coordination is ensured through the National Council for Scientific Research (NCSR) of the country, which was created in 1988 for the formulation of research policies and strategies, and for planning and identification of research priorities at the national level. This Council is headed by the Vice President of the Islamic Republic of Iran. The AR Commission, which is one of the many commissions of NCSR, is comprised mainly of representatives from MOA, MOJC and MOCHE. Some of the important duties of the Commission include: (i) setting up overall policies and priorities; (ii) allocation of funds for national research projects (see Section 3.3); and (iii) supervision, evaluation and coordination of national research programs.

## 2.2 The AR Institutions

### 2.2.1 The AR Institutes Affiliated to AREEO, Ministry of Agriculture

#### Mandate and Organization

AR under AREEO accounts for 39% of the pRYs and 38% of total financial resources of the NARS. The main mandate of its ARIs is research, which mobilizes around 85% of the time of the scientific and technical graduate staff, the remaining 15% is allocated mainly to seed production and studies/technology transfer.

AREEO, with its headquarters in Tehran, is responsible for general management, planning, evaluation, coordination, and international cooperation<sup>1</sup> of

<sup>1</sup> AREEO is also responsible for coordinating technology transfer activities and assessing farmers' needs.

- Twelve semi-autonomous AREEO ARIs listed in Table 2: 6 are commodity-oriented (sugar beet, rice, pistachio, citrus, date palm, cotton), 4 discipline-oriented (soil/water, plant pests and diseases, agricultural engineering, agricultural economics), and one farming systems-oriented (drylands)<sup>1</sup>.
- A network of 30 national/provincial AR Centers (ARCs) (at least one in each province), each headed by a Director: they host scientists from all the ARIs, who conduct specialized research (related with the national programs implemented by the ARIs) and integrated or multidisciplinary research to cater for the needs of the eco-region and develop specific technologies<sup>2</sup>.

The linkage in coordination of research activities is at two levels:

- First, at the National AR Council, chaired by the Deputy Minister of Agriculture (for agricultural research, education and extension), and composed of the Directors General of all the ARIs and two senior agricultural scientists, where the research program of each ARI is discussed. Inter- and intra-institutional cooperation is ensured.
- Second, at provincial AR Councils, composed of the heads of different ARC research divisions, extension bureaux, and representatives of the main AR college located in the region and development agencies<sup>3</sup>.

#### Human, Physical and Financial Resources

AREEO ARIs have a total number of 1644 scientific and technical graduate staff members consisting of 1639 nationals (including 88 PhD, 634 MS, and 917 BS) and 5 expatriates, who represent 1399 pRYs<sup>4</sup> (see Table 2). MOA made a strategic decision that the scientific staff must have a minimum qualification of MS degree.

AREEO has made special arrangements with MOCHE to upgrade the qualifications of its existing staff and to overcome the strong competition in admission to MS programs at the universities by improving the knowledge of its staff through extra tutorial help. Furthermore, through MOCHE and other international agencies/organizations, AREEO is sending a large number of its in-service staff outside the country for training at the PhD level. To improve the technical skills of its existing staff, AREEO organizes specialized training courses in Iran in collaboration with centers of excellence. At present, 207 staff members are studying for their PhD at national and foreign universities, and another 200 are enrolled for MS in national universities.

AREEO ARIs and Centers employ 1096 technicians and 3820 other support staff. The ratios of technicians and other support staff to researcher (0.7:1 and 2.3:1, respectively) are much under the general agreed upon standards (2 and 3–4, respectively).

A lot of improvement in research infrastructure, such as the construction of new offices, labs, greenhouses, and growth chambers during the last five years has taken place. The ARCs have modern buildings (labs, offices, greenhouses, growth chambers), a main research farm, and several AR research stations located in different agroecological regions of the province.

<sup>1</sup> The largest ARI is the Seed and Plant Improvement Institute (almost 600 graduate staff members), established in 1959. It has the following mandate: (i) improvement of field crops (winter and summer cereals, oilseed, vegetables, food legumes, forages) and horticultural plants for higher yield, quality, and resistance to biotic and abiotic stresses; (ii) developing improved production practices to realize higher production without damaging the resource base; (iii) conducting basic research (biotechnology, genetic manipulation) and providing technical backstopping to the AR Centers located in different ecological regions; and (iv) seed production and plant propagation. This Institute is playing a regional role (in West and Central Asia) by coordinating a wheat yellow rust network and by extending help and facilities in yellow rust monitoring and race identification.

<sup>2</sup> The major ARIs (SPII, PPDIR, SWRI, DARI) are physically apart from each other.

<sup>3</sup> The research projects of the AR Centers (ARCs) are reviewed and preliminarily approved at the provincial AR Council. Then, the approved projects are passed over to the relevant national ARI for technical review and approval. Finally, each research project is sent to the Research Coordination Committee (RCC) of AREEO for coordination at the national level and for ensuring its relevance to national and provincial research priorities. All research projects are financed and implemented only after the approval of RCC. The Bureau of Monitoring and Evaluation assesses and evaluates the ongoing research projects across the country. Members who review AREEO's research projects, together with the research team leaders concerned, are mainly distinguished university professors appointed by AREEO.

<sup>4</sup> pRYs = Number of researchers × 85% (percentage of the graduate staff's time devoted to AR, mentioned above).

The 1996/97 total budget of AREEO totaled 124 billion Iranian rials (IR) (US\$ 41.3 million), including IR 4.2 billion (US\$ 1.3 million) allocated by NCSR to support research projects approved by its Agricultural Commission. AR expenditures are roughly estimated at IR 115 billion (US\$ 35 million), out of which around IR 75 billion are for salaries and IR 32 billion for operation and capital costs (OCC). The available OCC per graduate staff member amounts to IR 19.5 million (US\$ 6,500), which is relatively low and inadequate, and does not match the financial research needs of the country (see Section 4.3).

From 1990 to 1997, the AREEO government budget increased in accordance with the annual inflation rate; from 1997, the annual increase of the budget has been lower than the inflation rate.

### Research Activities and Linkages

Most of the ARIs carry out applied and adaptive AR. The Soil and Water Research Institute (SWRI) provides information on the soil fertility status and balanced nutrient requirements of different crops and fruit trees in various ecological regions; it also provides information on crop water requirements and irrigation schedules of crops. The mono-crop institutes, such as rice and cotton, are carrying out studies on rice- or cotton-based cropping systems to solve the intricate and complex problems retarding the overall productivity, besides conducting research on other aspects of those crops. The Agricultural Engineering Research Institute (AERI) is conducting studies on irrigation systems in view of the agro-climatic diversity to make optimum use of scarce water resources.

Some emphasis has been given recently to basic research at the major ARIs. For example, the Seed and Plant Improvement Institute (SPII) has established a biotechnology department to conduct research on genetic transformation in major crops, genetic analysis, and transfer of desirable genes into desirable agronomic backgrounds. The cereal pathology section of the cereal department is conducting basic research on cereal rusts of wheat (race analysis, identification and isolation of new sources of resistance from wild species of wheat and their transfer to cultivated varieties) and providing backstopping to breeders. Similarly, the Dryland Agricultural Research Institute (DARI) is conducting basic research on mechanisms of abiotic (cold and heat) tolerance from the physiological, genetic and agronomic points of view, and on developing strategies to overcome these stresses and increase productivity.

Relations with extension and development are structurally organized to meet the national agricultural requirements. AR is directed towards developing a research strategy/plan to accomplish the production goals set in the national development plan by the Government.

AREEO has recently set up a growing network of international scientific relations. Relationships with the CGIAR and its International AR Centers (IARCs) were established from the very beginning of the creation of the CGIAR; they are currently very strong (scientific programs, human resource development, scientific exchange visits) with:

- ICARDA: The relationship with ICARDA, established from the day of its inception (one of the major research centers of ICARDA for high elevation areas was in Tabriz, Iran), is very strong and concerns the improvement of agricultural production in the dryland areas of Iran, covering commodity research on bread wheat, durum wheat, barley, chickpea, lentil, faba bean, pea, forage legumes, oilseed crops, natural-resource management, exchange of improved germplasm of ICARDA-mandated crops, and strengthening the research capacity (infrastructure). With the strengthening of AREEO, collaboration with ICARDA is moving to the level of partnership.
- CIMMYT (wheat, maize and triticale germplasm); IRRI (improved, high-yielding, better-quality varieties of rice; rice germplasm for resistance to salinity, blast and other insects); ICRISAT (germplasm lines of sorghum and chickpea; breeding and plant protection program under irrigated conditions and sharing marker-assisted characterization information); CIP (germplasm of potato; joint research projects in Iran for the establishment of a potato seed production unit and technical and organizational assistance for the creation of the best methods of seed tubers); IPGRI (transfer of technology and exchange of information in the field of plant genetic resources); and ISNAR (AR research policy and management).

Recently, in cooperation with ICARDA and CIMMYT, AREEO started providing assistance to the countries of West and Central Asia in the field of wheat rusts (disease monitoring, screening of regional germplasm against various races of rusts, etc.) and cold-tolerant wheat and barley germplasm.

### **2.2.2 The AR Institutes affiliated to the Ministry of Jihad Construction (MOJC)**

#### Mandate and Organization

This Ministry, beside other activities, has been mandated to develop plans and research strategies for the sustainable use of natural resources and their conservation. MOJC operates through a Central Research Council which is responsible for project approval and formulation of research policies on animal sciences and natural resources (forestry, range, watershed management, soil conservation, fisheries). The MOJC Deputy Minister of Research and Training is

the Chairperson of the Central Research Council, with membership of directors of the relevant ARIs and some professors from the universities.

MOJC AR activities are carried out through seven ARIs in the fields of soil conservation and watershed management, forests and rangelands, animal sciences, serum and vaccine, and fisheries; a center for scientific information services, mentioned in Table 2<sup>1</sup>; and a research center in each province which receives technical backstopping from the ARIs. It also has a Center for Scientific Information Services located in Tehran.

These ARIs account for about 44% of the pRYs and 48% of the total financial resources of the NARS. They are responsible for the promotion, coordination and implementation of research activities. Their main mandate is research, which mobilizes around 75% of the time of the scientific and technical graduate staff

#### Human, Physical and Financial Resources

The MOJC ARIs have a total of 2055 graduate staff members, all national, who represent around 1576 pRYs (see Table 2). Among these graduate staff members, 119 and 698 are PhD and MS holders, respectively. To improve the technical and academic level of its staff, the policy followed by MOJC is very similar to that of MOA.

The number of technicians is 856 and that of support staff 3517. The ratios of technicians and other support staff to researcher (0.4:1 and 1.7:1, respectively) are also much under the general agreed upon standards.

The MOJC ARIs operate through their provincial research centers and a number of sub-stations, as well as pilot project areas, such as sand dune stabilization (Kashan) and water spreading and land reclamation (Fars). The ARIs and provincial research centers have very well-equipped laboratories and field facilities and are staffed with qualified personnel. Since MOJC is also responsible for natural-resource conservation, huge tracts of state land are at their disposal to carry out their natural-resource rehabilitation activities.

The 1996/97 total budget of the MOJC ARIs amounted to IR 166 billion (US\$ 55.3 million), including IR 6.3 billion (US\$ 2.1 million) allocated by NCSR to support the research projects approved by its Agricultural Commission. Around 70% of this budget is allocated to salaries and wages. Operation and capital costs (OCC) are estimated at US\$ 16.6 million, which represent US\$ 8,100 per graduate staff member, very insufficient to match the research needs.

#### Research Activities and Linkages

Research activities are concentrated on natural-resource (soil and water) conservation, watershed management, forest research, timber research, range management, animal sciences (breeding, nutrition, health, poultry), fisheries, rural development, and medicinal plants.

The linkages between various disciplines and institutions are not very strong. The transfer of technology and extension activities are carried out under another Deputy Minister within MOJC. There is a need for strong linkages between MOJC and the MOA institutions.

International cooperation is limited and developed mainly with two international AR centers: IWMI (implementation of a detailed program of joint research activities for sustainable and productive irrigation in Zayendeh Rood Basin, especially Roudasht area) and ICLARM (identification, prioritization and involvement of the necessary policy and strategy for fisheries).

### **2.2.3 The Other AR Institutions**

<sup>1</sup> The major institute of MOJC is the Forest and Rangelands Research Institute (FRRI) which conducts research and studies on forests, rangeland species and medicinal plant species, with large attention given to *Spruce sp.*, *Eucalyptus*, pine species, collection of forest and rangeland species, and *in situ* and *ex situ* conservation of genetic resources. Its mandate also includes research on technologies related to forest and rangeland products; support to national forest development programs in different ecological regions, such as Alborz and Zagros Mountains; and the maintenance of the Botanical Garden of Tehran and a national herbarium.

The second most important institute of MOJC is RSVRI, the oldest research institute in the country, which gained prestige and fame in this region due to its excellent work on production of vaccine and serum. This institute has four stations located in Shiraz, Mashhad, Tabriz and Ahvaz. It has strong collaborative links with the Ministry of Health in the production of several types of human vaccines and is the pioneer in integrating research with commercial production. It has strong collaboration with Merieux Institute, France.

These are the Research Institute for Agricultural Economics and Planning, the Tea Research Center, the Silk Worm Research Center, the Iran Desert Research Center, the College of Agriculture Research, and the Institute of Nutrition Sciences and Food Technology (see [Table 2](#)).

The Research Institute for Agricultural Economics and Planning (RIAEP) - This Institute, established in 1993 in Tehran within MOA, is directly affiliated to the Deputy Minister of Agriculture and not to AREEO. It is responsible for conducting research and studies in agricultural economics (land use and production, producer and input prices, investment policies, marketing/trade policies, farm income, etc.). Research represents about 60% of its activities. RIAEP currently employs 106 national permanent graduate staff members (5 PhD, 33 MS), who represent 64 pRys, and national consultants, mainly from the universities. Its total 1997 budget amounted to IR 18 billion (US\$ 6 million), IR 7 billion for salaries and IR 11 billion for OCC (US\$ 34,000 per permanent graduate staff member).

The Tea Research Center (TRC) - TRC, established at Lahijan under MOA in 1975, has 40 graduate staff members (including 2 PhD and 8 MS). Its mandate includes tea improvement (quantity and quality) and processing technology.

The Silk Worm Research Center (SWRC) - This Center, established at Rasht under MOA in 1978, has 15 graduate staff members (8 of whom are MS holders) who conduct research on silviculture (mulberry tree) and silk technology.

The Iran Desert Research Center, University of Tehran - Established in 1975, this Center has 20 academic staff members (17 PhD, 3 MS) mainly involved in research related to desert ecology and its protection and desertification, with some training activities at the postgraduate level (PhD, MS). It has stations in Yazd and Semnan.

The College of Agriculture Research, Tehran - Established in 1990, it is run by the National Scientific and Industrial Research Organization (NSIRO) affiliated to MOCHE. Its 55 academic staff members (11 PhD, 40 MS) are also mainly involved in research (80%), with training at the MS level in collaboration with the colleges of agricultural sciences (CASs).

The Institute of Nutrition Sciences and Food Technology (NCRAM), Tehran - This Institute was created in 1990 by the Ministry of Health for conducting research on human nutrition and food technology. Eighty percent of its 22 graduate staff members (7 PhD, 10 MS) are specialized in food technology.

## **2.3 The Colleges of Agricultural Sciences (CASs)**

### **Overview**

#### Mandate and Organization

Iran has 19 colleges of agriculture (CAs) and 5 colleges of veterinary medicine (CVMs), designated later as CASs, which are under the governance of the Ministry of Culture and Higher Education (MOCHE) (see [Table 3](#)).

Teaching is their main mandate; research and extension activities are generally limited (see below). All CASs provide a BS program. Six CASs (CAs of Gilan, Chamran and Tabriz; CVMs of Mashhad, Ahvaz and Urmia) offer MS programs; and eight (CAs of Karaj, Ferdowsi-Mashhad, Tarbiat-Modaress, Shiraz and Isfahan; College of Natural Resources-Karaj; CVMs of Tehran and Shiraz) offer education up to the PhD level. Besides degree training, all the CASs offer specialized diploma courses from time to time.

Each CAS is usually affiliated to a university, which is headed by a president and supervised by the University Council. The Council, which is responsible for formulation of policies and monitoring university plans and activities, is chaired by the university president and made up of vice presidents (usually five: education, student affairs, research, graduate studies, and administration and finance vice presidents), deans of different colleges, and three university professors.

Each CAS is headed by a dean who is appointed by the university president and is generally assisted by five deputies (homologous to the five vice presidents of the university). The dean chairs the Faculty Council, which consists of deputies, heads of departments and two or three college professors.

All curricula of higher education (BS, MS, PhD) are studied and formulated by the High Council of Curriculum Planning (HCOCP) affiliated to MOCHE and chaired by the Minister. The Council has several specialized commissions, including one for agriculture. Members of the Commission of Agriculture, which represents all fields of agricultural sciences, are appointed by MOCHE from distinguished professors of the main agricultural colleges around the country.

Establishment of new educational departments and colleges is authorized only by MOCHE. There is a special board within MOCHE to review all applications, and authorization is issued after fulfillment of certain criteria by relevant universities and/or colleges.

### Human, Physical and Financial Resources

The CASs have a total of 1555 academic staff members (asm), all national, including 597 PhD and 681 MS holders. The most important CASs are generally the oldest: the CAS of Tehran/Karaj (187 full-time asm) and Tabriz (103 asm), and the CVM of Tehran (111 asm). The CASs have 232 technicians and 2740 support staff.

At present, there are approximately 17,500 students enrolled in all the CASs (11.2 students per asm), including 2130 (87 females, 2016 males) preparing MS and 330 (of whom 6 are females) preparing PhD degrees. The average teacher to student ratio is 1:11.2, which varies between the different colleges; 1:10 (CA of Karaj) to 1:20 (CAs of Isfahan and Shiraz).

In 1997, the total budget allocated by the Government to the CASs amounted to about IR 54.1 billion (US\$ 17.8 million) out of which about IR 16 billion (US\$ 5.3 million) was spent on AR. The total OCC was estimated at about IR 8.7 billion (US\$ 2.9 million), which represents IR 5.6 million (less than US\$ 1,900) per academic staff member, which is far from meeting the training and research needs of the CASs.

### Research Activities

Officially, the academic staff members allocate 80% of their time to teaching and 20% to research in the diverse fields of irrigation, soil science, horticulture, agronomy and plant breeding, plant pathology, animal science, agricultural machinery, fisheries, etc.

The involvement of the academic staff members (all categories) in AR is relatively low and restricted, primarily due to their heavy teaching workload and limited financial resources for research. Presently, their AR activities are heavily dependent on graduate students. MOA and MOCHS have recently developed closer cooperation to make use of the scientific manpower of the CASs. MOA is encouraging its ARIs to engage academic staff of the CASs in collaborative research. MOA is also funding special projects in specific disciplines (topics) which are important to agricultural production but not being tackled by the staff of the ARIs due to lack of or inadequate technical manpower. MOJC has also pursued similar policies to strengthen research collaboration with the CASs in areas of natural resources and animal sciences.

Until now there has been a shortage of highly qualified academic staff although the Government or the private sector created or upgraded several colleges to provide education on a large scale. The academic staff was encouraged through additional financial compensation to teach at more than one college. The incentive of increased income from teaching may have also, to some extent, distracted the academic staff from engaging in research. Although there is some weight given to research publications and research achievements, the time and resources needed to make reasonable achievements may not be commensurate with teaching benefits. Therefore, the average percentage of human and financial resources allocated to AR activities at the CASs is much less than 20%; 10% should be a more realistic ratio, which would mean that the CASs represent only around 150 actual RYs. However, in recent years, attempts have been made to encourage the university staff to work on high-priority research projects in relation to national agricultural development, especially through the research projects supported by NCSR.

## **2.4 The Other NARS Institutions**

These "other NARS institutions" presented in Table 4 implement AR activities which generally cover a more or less small part of their mandate. They include scientific institutions and public agro-industrial enterprises.

### **The Other Scientific Institutions**

Many other scientific institutions, especially faculties of sciences, civil engineering, and economics, have relatively large numbers of staff members highly qualified in AR-related scientific fields (natural resources, irrigation, plant and animal biology, oceanography and fisheries, agricultural engineering, food processing, agricultural social sciences). Since a precise inventory of this scientific potential is not available, only the Nuclear Research Center for Agriculture and Medicine and the Faculty of Environment, University of Tehran, are mentioned here.

The Nuclear Research Center for Agriculture and Medicine (NRCAM) - NRCAM was established by the Atomic Energy Organization at Karaj in 1988. Forty percent of its 22 staff members (7 PhD, 12 MS) are currently involved in AR (breeding, genetics, food conservation with the application of irradiation; use of isotopes).

The Faculty of Environment, University of Tehran - Established in 1973, it has 20 academic staff members (17 PhD, 3 MS) mainly mobilized by training (at the PhD, MS, and BS levels), with some AR activities related to natural resources (soil, water, rangelands, and desert wildlife and habitat).



### **The Public Agro-industrial Enterprises**

Two public agro-industrial enterprises affiliated to the Ministry of Commerce run specialized research institutes: the Food Grain Organization and the Iranian Tobacco Company.

The Bread Research Institute (BRI), Food Grain Organization – BRI, established at Tehran in 1968, has 21 staff members (including 2 PhD and 4 MS) working (research–development) on bread technology.

The Tobacco Institute (TI), Iranian Tobacco Company – This old institute (created in 1937) has its center at Tirtash-Mazandran and stations at Shiraz, Fars, Urumia, and Rasht. Its 51 staff members (including 4 PhD and 10 MS) conduct research on tobacco improvement and technology.

## **3. AR RESOURCES**

### **3.1 Human Resources** (see Table 1)

More than 5600 scientists (all national except 5 expatriates) are working in the Iranian NARS and represent around 3610 pRys. The agricultural research and training institutions employ around 96% of this total staff, where 66% work at the specialized ARIs run by AREEO and MOJC and 28% at the CASs. Among these two large categories of institutions, it is worth noting the large differences in the academic level of their scientists: the CASs have the largest number and proportion of the highest trained scientists (597 PhD holders, i.e., 38% of the academic staff at the CASs, and 74% of the PhD holders of the two sets of scientific institutions), while the specialized ARIs have only 212 PhD holders (about 4% of the total scientific and technical graduate staff).

Since 1990, the numbers of scientists with PhD and MS degrees have shown steady growth, and strong attention has been given in the last decade to upgrade the academic level of the scientists in all the NARS institutions. With the expansion of facilities for postgraduate studies leading to MS and PhD in the country, as well as training in reputed overseas universities, a substantial increase of human resources over a period of less than a decade has resulted, and is expected to expand very rapidly in the next five years, especially at the MOA and MOJC ARIs.

Until 1990, the majority of the scientists were located in and around Tehran and Karaj at SWRI, PPDRI, SPII, RSVRI, and some of the other ARIs. Most of the research work was also conducted at these institutes. The ARCs in different parts were primarily used as testing sites for the technology developed in or around Tehran. However, a strategic decision to decentralize the research activities to specific production zones resulted in the creation of several ARIs (Cotton, Rice, Pistachio, Date Palm, Dryland Research Institutes, etc.) as well upgrading research infrastructure and facilities at a number ARCs, subsequently resulting in the posting (sometimes relocation) of senior and qualified scientists to those locations. Efforts were and are still being made to recruit young scientists within the provinces to avoid causing disruption in families. Although it is still not the ideal situation, it is improving fast and within 2–3 years it is expected to reach a satisfactory level.

MOCHE also upgraded several universities around the country to offer MS or PhD degree training; considerable efforts have been made to upgrade the technical knowledge of academic staff by sending a large number of young staff members outside the country for PhD degree training.

There used to be a large discrepancy in the salaries and benefits of scientific staff working at the teaching institutions and the ARIs. The scientific staff members at the universities were better paid and enjoyed several other benefits. During the last few years, the Government has taken measures to minimize or reduce these differences, which include improving the academic qualifications of ARI staff and increasing salaries and benefits to be commensurate with qualifications (academic degree), scientific achievements, and publications.

At present, the MOA and MOJC ARIs and the MOCHE CASs employ around 3300 technicians and 12400 other support staff (clerks, laborers, etc.). As seen above, most of the NARS institutions suffer a large deficit of technicians, which may considerably reduce the efficiency of the scientists.

### **3.2 Physical Resources**

The strategic decision to decentralize research into different production zones was accompanied with improving research infrastructure and facilities, equipment (lab and field), and scientific information and documentation facilities. For example, new ARCs buildings (laboratories, offices, greenhouses, etc.) were erected at Tabriz, Urumia, Mashhad, Isfahan, Shiraz, and Kermanshah. New institutes (Rice, Cotton, Pistachio, Date Palm and Dryland Research Institutes) were created in the suitable production areas. Huge investments were made to create farms and to secure technical staff for dryland research at Maragheh, Kermanshah, and Gachsaran. Efforts are still under way, not only to

further improve these facilities, but also to create additional facilities at other locations to cover the diverse agro-climatic areas for the purpose of developing more site-specific technologies to improve agricultural production in the harsher environments and preserve the natural resources.

The Government has taken special note of the degrading biodiversity in the country; therefore, it created several *in situ* conservation sites, such as Mian Jungle (crop plant diversity), Raftanjan (pistachio), and others for other important horticultural (date palm, deciduous fruits, pomegranate, etc.) and crop plants. Basic research on studying the genetic drift, in collaboration with centers of excellence, has been initiated at these conservation sites.

Since agriculture and conservation of natural resources is on the top of the national priority list, there is no lax or complacent thinking on the part of policy makers. Therefore, a large amount of money is reserved annually to further improve AR facilities to meet the future needs of the country.

### 3.3 Financial Resources

The total AR financial resources of the NARS are about IR 296 billion (US\$ 98.7 million), including IR 20 billion (US\$ 6.7 million) provided by NCSR to support AR projects of national importance<sup>1</sup>. Until now, almost the entire budget and funding are directly or indirectly provided by the Government. However, with the development of the private sector and cooperation with other national and international agencies, there is a scope of securing funds for AR projects. Therefore, efforts will be made to secure additional financial resources as well as develop collaboration with other agencies for integrating the entire AR system in the country.

The national AR expenditure represents 0.49% of agricultural gross domestic product (AGDP, estimated at US\$ 20 billion in 1996/97), which in actual terms represents more than one-third of the total research budget of the country. Such ratio has increased during the last decade, but still remains rather low compared with the 1% ratio recommended by some international organizations (World Bank, European Union, etc.). Further efforts are required to face the challenge of food self-sufficiency in the long term.

Areas of expenditure vary considerably between the NARS institutions; however, in most of the institutions salaries constitute the major portion of the budget (70 to 80% in the AREEO and MOJC ARIs) and the available OCCs are relatively low and inadequate for allowing satisfactory work conditions. In the AREEO and MOJC ARIs, OCC per graduate staff member amount to US\$ 6,500 and 8,100, respectively, which represent around US\$ 7,000 and 9,000 per pRY<sup>2</sup>. Such numbers are much under the "optimal" amount of US\$ 25,000–30,000 per RY used in the long-term plans designed by many developing countries, which means that the AR scientific potential is currently far from being fully mobilized.

According to this last reference, the AREEO ARIs have roughly around 350 actual RYs (25% of its pRYs) and the MOJC ARIs around 520 actual RYs (33% of the pRYs). As seen in Section 2.3, the CASs are facing a similar situation; they represent only 150 actual RYs (instead of 389 pRYs). Most of the other NARS institutions are in a similar position in terms of underemployment of their research potential<sup>3</sup>. Therefore, the NARS may roughly mobilize a rounded total of 1,100 actual RYs, as opposed to the 3,610 pRYs estimated above.

## 4. RESEARCH ACTIVITIES

### 4.1 Research Orientation

In the AREEO ARIs, research emphasis is mostly on breeding of different commodities and germplasm enhancement for maximum yield. Recently, research for enhancing crop tolerance to biotic and abiotic stresses has been emphasized and facilities have been developed for the different types of research.

<sup>1</sup> In 1998, about 99% of these NCSR funds were shared between MOCHE, MOA and MOJC (45% to MOCHE, 21% to AREEO, 32% to MOJC, and 2% to others).

<sup>2</sup> The numbers of pRYs are smaller than the number of graduate staff members, and part of the OCC is allocated to activities other than research (see note in Table 2 related to the procedure followed for estimating the AR financial resources of the ARIs).

<sup>3</sup> For the NARS institutions presented in Sections 2.2.3 and 2.4, under the assumption that 70 to 80% of their AR budget (IR 25 million) is allocated to salaries, the total OCC would amount to around IR 6.3 billion, i.e., US\$ 2.1 million for 248 pRYs or US\$ 8,500 per pRY, and the actual RYs would represent 31% of the pRYs and amount to around 80 aRYs.

Also, due to environmental degradation by application of pesticides and excessive and improper use of chemical fertilizers, research on integrated pest management (IPM), optimum use of fertilizers, and efficient use of water resources has been given high priority.

Rainfed farming systems play an important role in agricultural production. Therefore, in the last three years, a great deal of emphasis has been placed on the development of resource infrastructure on dryland farming systems.

In the MOJC ARIs, land degradation (water and wind erosion, salinization of some irrigated land, desertification, deforestation, etc.) receives high attention, as it is an acute problem in the development of agricultural production and sustainable use of natural resources. The Government has placed considerable emphasis on research as well as on implementation of watershed management projects, particularly in the Zagros Mountain region.

In addition, in MOJC, livestock nutrition, animal breeding and health research activities have been greatly enhanced, and appropriate human resources and funds have been allocated to these activities. Fisheries research has also been greatly developed and given priority.

For the future, it is planned to:

- Pay greater attention to research related to biodiversity and conservation of the agricultural resource-base and optimization of inputs with greater attention to matters related to exportable horticultural crops, vegetables, oilseed crops, industrial and ornamental plants, flowers, medicinal crops, post harvest technology and socioeconomics.
- Strengthen research related to sustainable agriculture, such as soil and water management, range management, agro-forestry, utilization of crops tolerant to biotic and abiotic stresses (diseases, drought, cold, salinity), IPM, fisheries, livestock management, and optimum utilization of agricultural inputs, namely, fertilizers and pesticides.
- Formulate research policies and strategies and set research priorities for long-term (25 years) development.

#### **4.2 National Linkages**

Although the research establishments of MOA and MOJC are autonomous within the relevant ministries, there exists a reasonably close relationship between the ARIs and the executive branches of ministries and development agencies. Until recently, research priorities were not strongly reflected in the National Development Program due to other pressing national needs. However, great strides have been taken to direct AR to the needs of agricultural development of the country.

In MOA and MOJC, extension activities are actually incorporated within the same organization which is responsible for research. However, there is a lack of satisfactory communication and coordination between extension and research scientists to implement the research findings under farmers' field conditions. For instance, AREEO scientists are encouraged to implement research-extension field trials in cooperation with extension specialists and with active presence of farmers and fruit producers, whereas in the case of universities, there is no such mechanism for technology transfer.

For the future, recommendations have been made for:

- Strengthening cooperation between MOA and MOJC with the universities for the implementation of multipurpose research and strategies.
- Providing adequate incentives to the private sector and NGOs for their active investments and participation in the NARS.
- Strengthening relations with the extension sector for the transfer of knowledge and technology from the research institutions and universities with active participation of farmers and producers.

#### **4.3 International Scientific Collaboration**

International linkages are currently globally limited. They consist mainly of cooperative and collaborative relations, essentially with a number of International AR Centers (IARCs), and are implemented by the AREEO ARIs (relations with ICARDA, CIMMYT, ICRISAT, IRRI, CIP, IPGRI, and ISNAR) and the MOJC ARIs (relations with IWMI and ICLARM).

### **5. CONCLUSION**

The strength of the Iranian NARS lies in its vast extensive network of AR centers and research stations in different agroecological zones. The richness of biodiversity in the major crops, horticultural plants, and livestock is universally recognized, which has provided a solid base to researchers/scientists, not only in Iran, but also in other parts of the world. There is no major financial constraint because of the solid national commitment to improving agricultural production. Due to the vastness of the country and enormous agro-climatic diversity, scientists have the opportunity to conduct research on any commodity/discipline all year round.

Due to the concentration of AR institutions in and around Tehran until recently, the desired impact of research discoveries or new technologies could not be significantly made or felt at the national level. The decentralization of AR activities is relatively new; therefore, the problem of cooperation and coordination among various research centers will have to be tackled carefully. Although, theoretically, the channels and mechanisms of cooperation and coordination have been defined among the different ministries (MOA, MOJC, MOCHE, MOC, MOH) and their ARIs, a lot still needs to be done to break the institutional, and, sometimes, human, barriers. Though some of the institutional walls are crumbling, developing multi-institutional and multidisciplinary research activities and sharing research and achievements will take a little time to overcome the existing situation.

There is also a need to develop farming and cropping systems-based research. Mono-crop institutes have to be brought in line with the farming system-based research. The integration of research by various ARIs, and a coordinated approach for transfer of technology will become more important.

International linkages are limited and need to be improved.

### Main Acronyms

**MOA:** Ministry of Agriculture. **MOCHE:** Ministry of Culture and Higher Education. **MOJC:** Ministry of Jihad Construction. **MOC:** Ministry of Commerce. **MOH:** Ministry of Health. **AREEO:** Agricultural Research, Education and Extension Organization.

**CAS:** College of Agricultural Sciences.

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Table 1 - The National Agricultural Research System (1997/98)

Values: Approximate data. \* See footnotes

NARS Institutions					AR Scientif. & Technic. Graduate Staff (Units)		AR Potential Res. Years		Total National Budget (Billion IR)*	National AR Expend/Res. (Billion IR)*		
No.	Name - Acronym Head Office - Year Established		Mandates AR Fields	Govern. Ministry	Nationals Total - (PhD, MS)		Exp.	Nat.			Exp.	
a	b		c	d	e	f	g	d	i	j	k	
2.1	12 AREEO Ag. Res. Institutes Tehran, Karaj, etc. (see Table 2.A)	AREEO 1937-94	AR (85%) - (AD) Crops, fruit, ...	MOA	1639	88,634	5	1394	5	124	114	
2.2	7 MOJC Ag. Res. Institutes Tehran, Karaj, etc. (see Table 2.B)	1926-93	AR (73%) - (AD) Forest, an. prod., fish...	MOJC	2055	119,698		1576		166	141	
2.3	Other AR Institutes (see Table 2.C)		AR - (AD) Diverse	MOA, ...	255	28,99		183		29	21	
2	Total AR Institutes				3949	235,1431	5	3153	5	319	276	
3.1	19 MOCHE Colleges of Agriculture Tehran, etc. (see Table 3.A)	Cas 1926-88	AHE - (AR) All	MOCHE	1286	471,573		322*		46	14	
3.2	5 MOCHE Colleges of Veterinary Medicine Tehran, etc. (see Table 3.B)	CVMs 1935-...	AHE - (AR) Anim. prod./health	MOCHE	269	126,108		67*		8	2	
3	Total Agr. Sciences Colleges				1555	597,681	0	389	0	54	16	
4	Total Other Institutions (see Table 4)				114	30,29	0	63	0	7	4	
5	Total NARS				5618	864,2151	5	3605	5	380	296	
Exchange Rate: US\$ 1 = IR 3000, IR 1000 = US\$ 0.33 (1997 average rate)					Actual Research Years (aRY's) (Estimate) -->			1100	AR Expend. (US\$ Million) - >			98.7

MOA: Ministry of Agriculture, MOCHE: Min. of Culture and Higher Education, MOJC: Min. of Jihad Construction, MOC: Min. of Commerce, MOH: Min. of Health, AREEO: Ag. Research, Education and Extension Organization.

c. Mandates: AR ( %): Approximate average % of human resources devoted to ag. research (AR); R: Research; AHE: Ag. higher education; AD: Ag. development/services (for AR and AHE institutes: seed production, soil and water analysis, extension, studies, etc.) k, l Potential research year (pRY) = equivalent full-time researcher; for the FASs, the pRYs have been estimated by multiplying the number of academic staff by 0.25. k For the AR institutes, AR financial resources have been roughly estimated through the following formula: Total budget = [a + 0.5(100% - a)], a being the % of time devoted to AR by the graduate staff

\* Notes: j, k All financial resources are national

National/Total AR expenditures = 0.49% of the AGDP (US\$ 20 billion in 1996)

**Table 2 - The Agricultural Research Institutes**
*(Values Approximate data)*

Agricultural Research Institutes (RI)				Scientific & Technical Graduate Staff (Units)		AR Potential Res. Years		Total Budget* (billion IR)	AR Expend./Res.* (billion IR)		
No	Name - Acronym Head Office - Year Established		Mandates AR (%)* - areas	National Total - (PhD, MS)	Exp.	Nat.	Exp.	Nat.	Total TE		
1	Soil and Water RI - Tehran	SWRI - 1966	90	Soil, water manag.	298	10, 135		268	16.7	15.9	
2	Seed and Plant Improvement Inst. - Karaj	SPRI - 1959	85	Plant breeding	598	18, 155	2	508	2	35.7	33
3	Sugar Beet RI - Karaj	SBRI - 1937	85	Sugar Beet	45	4, 35		64		5.3	4.9
4	Rice RI - Rasht	RRI - 1993	90	Rice	62	2, 25		56		3.6	4.9
5	Pistachio RI - Rafsanjan	PRRI - 1992	90	Pistachio	27	2, 10		24		1.3	1.3
6	Date Palm RI - Ahwaz	DPRI - 1994	90	Date palm	24	0, 15		21		1.7	1.6
7	Citrus RI - Ramasr	CRI - 1992	90	Citrus	26	1, 12		24		1.3	1.2
8	Dryland Agricultural RI - Maragheh	DARI - 1991	85	For. pastu., cereals, legum.	73	1, 25	1	62	1	8.2	7.6
9	Plant Pests & Diseases RI - Tehran	PPDRI - 1962	90	Crop protection	262	35, 125	2	236	2	14.9	14.2
10	Agricultural Engineering RI - Karaj	AERI - 1988	90	Ag. engineering	44	3, 55		11		7.1	6.7
11	Agricultural Economic Res. Bureau - Tehran	AERB - 1985	90	Ag. economics	24	2, 14		21		0.5	0.5
12	Cotton Research Institute - Gorgan	CRI - 1996	90	Cotton	45	3, 13		30		1.3	1.2
13	Agricult. Res., Educ., and Extens. Organ. - Tehran	AREEO - 1975/90	90	AR management	45	7, 15				26	23
A	Total AREEO/MOA Institutes				1639	88, 634	5	1394	5	123.7	114.3
1	Soil Cons. & Watershed Manag. RI - Karaj	SCWMRI - 1993	70	Watersheds	193	19, 67		135		65.7	55.8
2	Forest and Rangelands RI - Tehran	FRRI - 1968	85	Forest, rangelands	544	30, 184		462		24	26.8
3	Animal Science RI - Karaj	ASRI - 1933	85	Animal production	268	15, 73		228		17.2	15.9
4	Razi Serum & Vaccine RI - Karaj	RSVRI - 1925	85	Animal health	306	17, 200		200		21.9	14.2
5	Fisheries Res. and Training Inst. - Tehran	FRTI - 1990	90	Fisheries	314	21, 58		251		16	14.4
6	Natural Res. & Anim. Sc. Engin. & RI - Tehran	NRAERI - 1983	70	Ag. engineering	322	10, 65		225		12	10.2
7	Rural RI - Tehran	RRI - 1984	90	Rural economics	83	7, 41		75		1.3	1.3
8	Center for Scientific Information Services - Tehran	CSIS - 1993	90	Ag. documentation	25	0, 10				2.5	2
B	Total MOIC Institutes				2055	119, 698	0	1576	0	165.7	140.6
1	Res. Institute for Agric. Economics and Planning (MOA) - 1993		60	Ag. economics	106	5, 33		64		18	11
2	Tea Research Center - Lahijan (Gilan)	(MOA) TRC - 1995	90	Tea (crop, processing)	44	2, 8		32		2.5	1.2
3	Silk Worm Research Center - Rasht	(MOA) SWRC - 1978	70	Mulberry tree, silkworm	15	0, 8		11		1	4.9
4	Iran Desert Res. Center, Univ. of Tehran - Tehran	(MOCHIE) - 1975	85	Desert ecology	17	3, 10		14		2.9	2.7
5	College of Agriculture Research (NSIRO) - Tehran	(MOCHIE) - 1990	90	Agriculture	55	11, 40		39		4	3.6
6	Inst. of Nutrition Sc. & Food Technology - Tehran	(MOH) - 1990	80	Food technology	22	7, 10		11		2	1.2
C	Total Other AR Institutes				255	28, 99	0	183	0	29.4	21.1

\* Mandates AR (%) = Approximate % of time of the graduate staff devoted to AR. All the financial resources are national. The AR financial resources of the AR institutes were roughly estimated through the following formula: Total budget  $\times$   $[(n + 0.5(100 - n))]$ , n being the % of time devoted to AR by the graduate staff, except for the ARIs involved in animal health and agro-economics (see Chapter 3: Methodology Used in Preparing the Monographs).

**Table 3 - The MOCHE\* Colleges of Agricultural Sciences (1996/97)**

\* MOCHE: Ministry of Culture and Higher Education.

Note: All human and financial resources are national.

Agricultural and Veterinary Colleges				Scientific & Technical Graduate Staff (Units) Total - (PhD, MS)	Total Budget (billion IR)	
No.	Name Head Office - Year Established	Degree				
3.1	College of Agriculture/Univ. of Tehran/Karaj - Tehran	1926	BS/MS/PhD	187	69 , 67	7.4
3.2	College of Natural Resources/Univ. of Tehran/Karaj - Tehran	1963	BS/MS/PhD	42	30 , 10	1.4
3.3	College of Agriculture/Univ. of Ferdowsi- Mashhad	1973	BS/MS/PhD	120	35 , 65	3.2
3.4	College of Agriculture/Univ. of Tarbiat - Modares - Tehran	1982	BS/MS/PhD	39	27 , 12	1.2
3.5	College of Agriculture/Univ. of Gilan - Rasht	1977	BS/MS	45	10 , 24	2.4
3.6	College of Agriculture/Univ. of Shiraz - Shiraz	1955	BS/MS/PhD	79	42 , 18	3.1
3.7	College of Agriculture/Univ. of Tabriz - Tabriz	1955	BS/MS	103	46 , 36	3.9
3.8	College of Agriculture/Univ. of Technology - Isfahan	1979	BS/MS/PhD	89	41 , 27	3
3.9	College of Agriculture/Univ. of Chamran - Ahvaz	1955	BS/MS	67	24 , 31	2
3.10	College of Agriculture/Univ. of Zanjan - Zanjan	1974	BS	59	16 , 31	1.5
3.11	College of Agriculture/Univ. of Bouali-Sina - Hamedan	1984	BS	41	10 , 21	1
3.12	College of Agriculture/Univ. of Mazandaran - Sari	1988	BS	72	25 , 40	1.9
3.13	College of Agriculture/Univ. of Urumia - Urumia	1955	BS	68	27 , 31	2
3.14	College of Agriculture/Univ. of Bahonar - Kerman	1983	BS	37	7 , 18	0.9
3.15	College of Agriculture/Univ. of Gorgan - Gorgan	1968	BS	90	23 , 67	5.9
3.16	College of Agriculture/Univ. of Razi - Kermanshah	1983	BS	23	7 , 16	1.2
3.17	College of Agriculture/Univ. of Shahr - Kord	1977	BS	26	4 , 19	0.8
3.18	College of Agriculture of Ramin - Ahvaz	1956	BS	49	13 , 18	1.8
3.19	College of Agriculture of AbuRayhan - Varamin	1972	BS	50	15 , 22	1.9
3.A	Sub-total MOCHE Colleges of Agriculture			1286	471 , 573	46.5
3.20	College of Veterinary Med./Univ. of Tehran - Tehran	1933	BS/MS/PhD	111	62 , 26	3.4
3.21	College of Veterinary Med./Univ. of Ferdowsi - Mashhad	1973	BS/MS	28	13 , 11	0.7
3.22	College of Veterinary Med./Univ. of Chamran - Ahvaz	1955	BS/MS	36	8 , 23	0.9
3.23	College of Veterinary Med./Univ. of Urumia - Urumia	1965	BS/MS	44	18 , 26	1.1
3.24	College of Veterinary Med./Univ. of Shiraz - Shiraz	....	BS/MS/PhD	50	25 , 22	1.5
3.B	Sub-total MOCHE Colleges of Veterinary Medicine			269	126 , 108	7.6
3	Total Agricultural Sciences Colleges (3.A + 3.B)			1555	597 , 681	54.1

**Table 4 - The Other Institutions (1997)**

Indices: Approximate data. Note: All human and financial resources are national.

No.	Name - Acronym Head Office - Year Established	Mandates AR (%) * - AR areas	Govern. Min.	Scient. & Techn. Graduate Staff Total - (PhD, MS)	AR Potential Res. Years	Total Budget (billion IR)	AR Budget (billion IR)
1	Nuclear Res. Cent. for Agric. and Medicine Karaj	NCRAM 1988	40 Ag, biology	AEO*	22 7, 12	9	2 0.8
2	Faculty of Environ. - Univ. of Tehran Tehran	1973	25 Soil, water, range	MOCHE	20 17, 3	5	2 0.5
3	Iranian Cereal Res. Inst. (State Grain Organ.) Tehran	ICRI 1968	45 Cereal technology	MOC	21 2, 4	9	1 0.7
4	Iranian Tobacco Institute (Iran. Tob. Comp.) Tirtash - Mazandaran	ITI 1937	80 Tobacco (crop, processing)	MOC	51 4, 10	40	2.2 2
<b>C</b>	<b>Total Other Institutions</b>			<b>114</b>	<b>30, 29</b>	<b>63</b>	<b>7.2 4</b>

\* AEO: Atomic Energy Organization. MOCHE: Min. of Culture and Higher Education. MOC: Min. of Commerce.

## THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF TURKEY<sup>1</sup>

### 1. HISTORICAL BACKGROUND

The capacity to provide manpower and new scientific and technical knowledge for agricultural development in Turkey started with the establishment in Istanbul of a Veterinary School in 1842 and an Agricultural School in 1881. Two additional Veterinary Research Centers were established in Istanbul and Ankara in 1914 and 1921, respectively. After the foundation of the Turkish Republic in 1923, a viable pattern of organization for agricultural research (AR) within the Ministry of Agriculture and the universities emerged and has been expanding.

In the 1930s, several separate AR stations and institutes (RIs) were founded in various fields: the Poultry RI of Ankara; the Viticulture RIs of Manisa and Tekirdağ (founded in 1930); the Plant Protection RIs of Adana and İzmir (1931); the Citrus RI of Antalya and the Cotton Research Institute of Nazilli (1934); the Mediterranean Agricultural RI of Antalya (1935); the Olive RI of İzmir, the Livestock RI of Ankara and the Fruit RI of Malatya (1937); and the Fig RI of Aydın (1938). No significant institutional development was recorded during the 1940s except for the establishment of a research station in Samsun on the Black Sea coast in 1944.

In 1950s, three Veterinarian Research and Control Institutes were founded in Konya, Elazığ and İzmir, and a Plant Protection Research Station in Diyarbakır. The first Forest Research Institute (FRI) was created in 1952 at Bolu (first station), then moved to Ankara where the center headquarters managed a network of 8 regional RIs and 7 research forests. Regional RIs were established in Adana, Diyarbakır, İzmir, Erzurum, and Edirne in 1961, 1962, 1963, 1969, and 1970, respectively. The Foot and Mouth Disease Research and Vaccine Production Institute was established in 1967 in Ankara and the Poultry Diseases and Vaccine Production Institute in 1985 in Manisa.

Agricultural higher education (AHE) of modern Turkey started with the first agricultural higher school, named the Higher Agricultural Institute, which was established in 1933 in Ankara and consisted of five faculties (agriculture, agricultural arts, veterinary sciences, forestry, and natural sciences). Later, in 1946, Ankara University was established; in 1948, the Agricultural and Veterinary Faculties joined this new establishment, and the Forestry Faculty was transferred to Istanbul University.

Agricultural sciences education and research have received increasing attention since the 1950s. During 1958–1967, three faculties of agriculture (FOAs) were established in Erzurum, İzmir, and Adana; their number increased to seven in the period 1981–1985; nine more FOAs were created by 1993, and this steady increase continued in recent years, the total reaching 23. After the establishment of the first veterinary faculty in Ankara in 1933, a second one was founded in Elazığ in 1970; three other faculties of veterinary medicine (FVMs) were opened in İstanbul, Bursa and Konya in the 1970s; then the number of FVMs increased rapidly, especially during the last decade, to the current total of 14. The first faculty of forestry (FF) was established in İstanbul in 1948; Trabzon FF is the second oldest; and the remaining seven current FFs were established only recently.

After 1923, governmental work related to the agriculture sector was distributed among several ministries. The Ministry of Agriculture (MOA) came to existence, for the first time, in 1937; at that time, it consisted of three General Directorates (GDs): Agriculture, Veterinary Service, and Forestry. For the planning and coordination of research activities, each GD had a research division. The following years, 1937 until the 1980s, the number of GDs of MOA reached 23. In 1971, most of the AR activities of MOA were grouped, with the exception of animal health, within a separate GD of AR (GDAR), which was abolished in 1981 and merged with the Extension Division in an enlarged GD for Agricultural Affairs (GDAA). The merging in 1983 of the Ministries of Agriculture and Rural Affairs into the Ministry of Agriculture, Forestry and Rural Affairs (MAFRA) and the consecutive administrative reorganization led to the termination of GDAA and splitting its research activities into five GDs: the GD of Projects and Implementation (GDPI), responsible for research on crops, forages, agronomy, and animal husbandry; the GD of Protection and Control (GDPC), for research in plant protection, animal health, food, feed, and seed quality control; the GD of Rural Services (GD RS), for soil and water management research; the GD of Forestry, for forestry research; and the GD of Organization and Support (GDOS), for handicraft and leather research. In 1987, MAFRA established the High Council for Research and Development (HCRD) for coordinating AR activities and for general guidance of AR policy (priorities, linkages, research/development, manpower, etc.).

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The initiation of the Turkish AR Project (TARP) in 1990 opened the doors for significant new changes, facilitated by the resources available through a large World Bank loan (see Section 3.3). In 1991, MAFRA split into the Ministry of Agriculture and Rural Affairs (MARA) and the Ministry of Forestry (MOF). The same year, MARA established a new GD of AR (GDAR), which merged AR resources and activities of the previous GDPI, GDPC, and GDOS. In 1993, the Rural Affairs Division with its AR institutes (ARIs) were combined into the GD of Rural Services (GDRS) under the governance of the Prime Ministry.

## 2. THE CURRENT NARS

### 2.1 Overview (see Table 1)

Currently, the Turkish NARS consists of the following three main components:

- The governmental AR institutions involved mainly in AR: (i) the General Directorate of Agricultural Research (GDAR) within the Ministry of Agriculture and Rural Affairs (MARA), which governs 55 ARIs; (ii) the Agricultural Economics Research Institute, also governed by MARA; (iii) the Research Division of the General Directorate of Rural Services (GDRS), affiliated to the Prime Ministry, which manages 11 national ARIs specialized mainly in soil and water management; and (iv) the Research Directorate of the Ministry of Forestry (MOF), with its 11 ARIs. All these institutions account for about 50% of the potential research years (pRys or equivalent full-time researchers) and 78% of the total financial resources of the NARS. They are presented in Section 2.2.
- The 46 faculties of agricultural sciences (FASs, including the faculties of agriculture, veterinary medicine, forestry, and fisheries) under the governance of the Ministry of Education through the Higher Education Council. These FASs meet around 37% of the pRys and 4% of the total financial resources of the NARS (see Section 2.3).
- The “other NARS institutions” (some research institutes, many university institutions, some public agro-industrial enterprises and development organizations) in which AR activities cover a more or less small part of their mandate. They meet the remaining resources of the NARS (around 13% of the pRys and 18% of the total funds) (see Section 2.4).

The Scientific and Technical Research Council of Turkey (STRCT), directly governed by the Prime Ministry, has an official mandate for defining national research policies in all domains, including agriculture. Its main role is to financially support research of individuals, teams, or collaborative programs. STRCT has several functional groups, such as the Agriculture and Forestry and the Veterinary and Livestock groups, to evaluate project proposals and define priority areas or topics. The US\$ 4 million allocated from TARP for the management of STRCT has significantly improved its activities in recent years.

Currently, there is no single national AR authority which is officially responsible for direction of the overall national AR policy. The Cabinet- and Ministerial-level decisions, such as employment and funding policies, are supervised by the State Planning Organization (SPO) and related ministries, but GDAR, GDRS, the universities, and the other NARS institutions and their respective ministries make research-policy decisions independently from each other. However, it is worth mentioning some major facts:

- Most of the ARIs affiliated to MARA, GDRS, and other bodies have complementary mandates; accordingly, overlapping of activities is essentially between these ARIs and the FASs.
- Within MARA, whose ARIs gathers around 39% of the pRys and 55% of the total financial resources of the NARS, the High Council of Research and Development (now called the High Council of Agriculture), chaired by the Minister of Agriculture, develops, together with MARA’s Research, Planning and Coordination Council (RPCC), macro-level research policies for MARA, which serve as an implicit reference for the overall national AR policy. This, together with TARP, results in rather efficient coordination with GDRS, MOF, and other institutions (see Section 4.2).

The international connections of the Turkish NARS were established in the 1960s, and have grown strong in recent years with the support of the World Bank, FAO, UNDP, EU, and other international institutions. Various research and development projects have been executed, improving agricultural productivity and AR capacity. As a consequence of these efforts, a number of institutions with international status have been established in recent years. Among these are the Central Veterinary Research Institute in Istanbul (1965); the International Center for Winter Cereal Improvement, established in Konya (1987), and the International Agro-Hydrology Research and Training Center established in Menemen-Izmir (1996).

## 2.2 The Governmental Agricultural Research Institutions

### The General Directorate of Agricultural Research (GDAR)

#### Mandate and Organization

Considering the number of research entities, land, physical plants, trained research staff, and financial resources available, institutions affiliated with GDAR constitute the most important component of the NARS; they account for around 39% of the pRYs and 55% of the total financial resources of the NARS.

GDAR has a national research mandate in the fields of agronomy, horticulture, plant protection, animal husbandry and health, fisheries, food technology, and other related areas. It governs 55 semi-autonomous ARIs<sup>1</sup> scattered all over the country (see Table 2), including:

- 7 central ARIs, specialized in field crops, horticulture, plant protection, food technology, livestock, fisheries, and animal health, responsible for coordination and guidance of the other GDAR ARIs in their fields;
- 18 single or multiple crop-commodity ARIs (in addition to 2 central ARIs), which generally deal with breeding, agronomy, and quality aspects of the relevant crop(s);
- 3 plant protection ARIs (in addition to 1 central ARI), which conduct applied research on pests, diseases, nematodes, and weed problems of major crops;
- 8 animal husbandry and breeding ARIs (in addition to 1 central ARI), which carry out production-related research covering relevant aspects, including leather research;
- 9 veterinary control and research institutes (in addition to 1 central ARI), which work mainly on disease prevention and control;
- 2 fishery ARIs (in addition to 1 central ARI), which carry out preliminary research on both marine and freshwater environments; and
- 8 regional pluri-sectorial ARIs, responsible for searching for solutions to overcome production constraints of all the major commodities in the mandate region.

An AR Council (ARC) develops and oversees the AR policy for GDAR as a basis for funding its research programs. Three Research Advisory Committees (RACs) on field crops, horticulture, and livestock provide advice to ARC on GDAR's research programs and projects, and recommend annual funding allocations for them. Eight technical departments (field crops, horticulture, livestock and fisheries, plant protection, animal health, food technology, research management, coordination) manage research programs in their fields; they are responsible for planning, monitoring and evaluating research activities within programs. The 7 central ARIs are responsible for establishing joint research activities among institutions as well as providing technical support, training, and information exchange. The ARI Directors are responsible for managing their institutes and research projects.

The main mandate of the GDAR institutes is research (essentially strategic, applied, and adaptive) which mobilizes around 65% of the time of the graduate scientific and technical staff; the rest of their time is devoted mostly to development activities (seed and animal vaccine production, regulatory and control services, extension support, producing reports for decision makers, etc.).

#### Human, Physical and Financial Resources

GDAR currently (November 1998) has around 4,915 permanent full-time staff, all nationals, consisting of

- 1,355 scientific and technical graduate staff (265 PhD, 310 MS, 780 BS), who represent around 881 pRYs<sup>2</sup>;
- 130 technicians and 3420 other support staff (clerks, accountants, laborers, etc), who are far from covering the needed numbers<sup>3</sup>.

In most of the ARIs, infrastructure, such as land (total: around 9,000 ha), buildings, and laboratories, are usually adequate and well equipped. But library and documentation facilities in some research institutions need

<sup>1</sup> The ARIs directly receive their governmental budget (not through GDAR).

<sup>2</sup> pRYs = Number of researchers on duty × 65% (percentage of the graduate staff's time devoted to AR).

<sup>3</sup> The ratios of technicians and other support staff to researcher (0.1 and 2.6, respectively) are below the general agreed upon standards (2 and 3–4).

improvement. To develop the existing search capacity of the libraries, a communication system network has been installed, which facilitates electronic communication among the institutions of GDAR. A central library (with CD-ROM search facility), which is accessible on-line to all research institutes, has also been installed.

In 1997, GDAR's total financial resources amounted to 11,300 billion Turkish lira (TL) (US\$ 72.6 million), consisting of:

- US\$ 66.7 million from national sources, mainly from the government budget (US\$ 59.9 million)<sup>1</sup> and from self-earned funds (US\$ 6.8 million)<sup>2</sup>, and
- US\$ 5 million from a World Bank loan<sup>3</sup> and US\$ 0.9 million from other external grants (principal donors: CIMMYT, ICARDA, IFAD).

Salaries absorb 79% of GDAR's total resources; the remaining 21% is allocated to operational/capital costs (OCC) which amount to US\$ 15.2 million, i.e., US\$ 11,200 per graduate staff member, which is about half the budget needed for providing satisfactory resources for research (see Section 4.3).

#### Research Activities and Linkages

With the initiation of the Turkish AR Project (TARP), a national, multidisciplinary, multi-institutional research program concept has been accentuated and encouraged, and GDAR developed a research master plan that established formal priority-setting mechanisms for its research agendas. Within this framework, during the last two years GDAR identified 17 research priority areas, each with several research programs, headed by a research program coordinator residing at the lead ARI, and a program manager positioned at the headquarters. Six of the research priority areas are high priority (oil seeds and food legumes, dairy and beef, industrial crops, cereals, fruits, vegetables), 6 are medium priority (processed food, feed and forages, fish and poultry, sheep, nuts, natural resources), and 5 are low priority ones (pharmaceuticals and agricultural chemicals, apiculture, silk, processed animal products).

GDAR's major research programs aim to develop better-yielding, high-quality crop varieties and crop production technologies for durum wheat, bread wheat, barley, food legumes, sunflower, cotton, forage crops, maize, potato, and various vegetable crops and fruit trees. High-priority programs also cover integrated pest management of several field and horticultural crops. Programs of animal husbandry, breeding and health in addition to fisheries have received strong emphasis. Conservation of genetic resources has been identified as an important area to be supported in the future and a specific project on *in situ* conservation has been launched.

Currently, GDAR's research capacity is more pronounced in some research areas or disciplines. The majority of scientists (380) are employed in institutes whose major responsibility is in field crops research, while the minority (72) are employed in fishery ARIs. The numbers of research scientists at the institutes working on horticulture, animal diseases, livestock, and plant protection are 300, 257, 114, and 135, respectively<sup>4</sup>.

There is a strong imbalance in the allocation of human and research funds among the regions. According to Mizrak et al. (1997), in 1993, the developed regions located in the western and southern parts of the country (central north, Aegean, Marmara-Thrace, and Mediterranean), which include 52% of the arable lands and 51% of the agricultural holdings, employ approximately 80% of the researchers and absorb 82% of the budget, while the underdeveloped regions located in the eastern and northern parts (northeast, southeast, Black Sea, central east, and central south), almost equally important as the previous ones, receive less attention. In recent years, a gradual shift towards better regionalization has been observed with positive (mainly stronger interaction with farmers and agricultural industries) and negative effects (higher fragmentation of the available resources, less efficient overall coordination, etc.).

<sup>1</sup> From the Ministry of Finance (MF) for salaries and MARA (through the State Planning Organization) for OCC.

<sup>2</sup> These self-earned resources (revolving funds) include revenues from sales of farm produce (improved varieties, animal breeds, etc.) and services (analysis, consultancies, etc.), and revenues from research contracts with STRCT, some national agro-food industries, and international research organizations.

<sup>3</sup> The originally agreed upon World Bank loan of US\$ 55 million for the period of 1992–1998 was reduced to US\$ 49 million in 1997. Of this total, US\$ 16 million were allocated to GDAR, 11 to GDRS, 7 to MF, 4 to the Agricultural Economics Institute, 4 to STRCT, and 7 were not allocated. By October 1998, GDAR had spent the US\$ 14 million of its allocation.

<sup>4</sup> The qualifications of the scientists vary significantly according to the ARI; in terms of the proportion of PhD or MS holders to total researchers, the plant protection ARIs come first with 65% and the animal husbandry and breeding institutes come last with 7%. This proportion in other domains (e.g., field crops, horticulture, animal diseases and fisheries) is around 40%.

GDAR has provided valuable research output to the nation's agriculture mainly in plant breeding and crop management and protection, where it has a relatively well-trained scientific cadre and adequate research facilities. In addition, it has a core group of qualified research staff and growing research capacity in plant genetic resources conservation. However, GDAR's research potential and past accomplishments have been rather limited in animal breeding, husbandry, health, and fisheries.

GDAR ARIs have strong connections with international scientific organizations, especially with international AR centers, which support research activities and out-of-country training. These relationships began with the initiation of collaborative activities with the Rockefeller Foundation (1969) and CIMMYT (1971), especially for the improvement of wheat and corn; this collaboration helped to improve the research capacity of the ARIs in terms of physical infrastructure and human resources. Relationships with ICARDA started in 1986 and have been intensifying in recent years, especially through collaborative activities with the Central RI for Field Crops (CRIFC, Ankara). These joint efforts have resulted in the establishment of the International Winter and Facultative Wheat Improvement Program (IWWIP), based in Turkey, and jointly executed by Turkey/CIMMYT/ICARDA together with Oregon State University. International relationships are being strengthened with CIHEAM as well as with neighboring countries and countries of the former Soviet Union.

### **The Agricultural Economics Research Institute (AERI)**

AERI, which was established in 1996, is affiliated with MARA Research, Planning and Coordination Council (RPCC), not GDAR. It is responsible for conducting research and studies in agricultural economics on related issues, such as land use and production, producer and input prices, investment policies, export opportunities, marketing and trade policies and their effects on farm income and employment, etc.

AERI is located in Ankara, and currently employs 15 permanent staff members, of whom 12 are researchers (4 PhD, 2 MS, 6 BS), and a large number of consultants. Its total budget for 1997 was approximately US\$ 1 million, with a large TARP contribution.

### **The Research Division of the General Directorate of Rural Services (GDRS)<sup>1</sup>**

#### Mandate and Organization

The GDRS Research Division, the second largest NARS organization, is responsible for the overall coordination (research resources and planning, assessment, etc.) of 11 ARIs (1 national and 10 regional)<sup>2</sup> (see Table 3), whose research mandates focus on soil fertility, soil and water conservation, hydrology, irrigation and soil physics, drainage and land reclamation, and mechanization, especially under irrigated conditions.

Each ARI has a Research Council, and there are seven research working groups for different research areas. Research plans are developed by Research Councils of each ARI through consultation with the working groups. The Research Council meets annually with all institute members to review the progress of research activities and make recommendations.

The main mandate of the GDRS ARIs is research (essentially adaptive), which mobilizes around 70% of the time of their scientific and technical graduate staff. The remaining time is mostly devoted to development activities, such as soil and water analysis for various parties (farmers, institutions), mapping of soil characteristics, consultation and preparation of reports on related issues, etc.

#### Human, Physical and Financial Resources

GDRS ARIs currently (November 1998) have 204 graduate staff (including 35 PhD, 100 MS, 87 BS)<sup>3</sup>, who represent around 143 pRY. This graduate staff enjoys relatively better employment conditions than GDAR researchers and better labor resources, which explains their higher academic level. GDRS ARIs also employ 100 support staff (technicians, clerks, accountants) and 1,330 laborers (approximately 60% are part-time workers).

GDRS ARIs possess about 17,000 ha at different locations, which are sufficient for research activities. Offices, laboratories, vehicles, and equipment are adequate for the research activities, mainly due to TARP contribution in recent years, though strengthening is required in specific areas. Information services of GDRS are one of the best among the governmental institutions, with sufficient printing and computer resources and access to Internet.

<sup>1</sup> GDRS, directly governed by the Prime Ministry, is responsible for developing research and developmental activities for improvement of rural affairs, soil fertility, and water use in the country. The Research Division is within the Planning and Coordination Department, one of the 17 GDRS Departments.

<sup>2</sup> The Research Division is also responsible for the International Agro-Hydrology Research and Training Center (IAHRTC).

<sup>3</sup> Without counting IAHRTC (9 researchers).

The total 1997 financial resources of the GDRS Research Division (without the International AHRTC) amounted to around US\$ 19.6 million<sup>1</sup> (TL 3,060 billion), consisting of

- US\$ 16.4 million from national sources, mainly from the government budget (and US\$ 0.2 million from self-earned funds);
- US\$ 3 million from the World Bank loan, and approximately US\$ 0.2 million from external grants (principal donors: ICARDA, IWMI, STOAS/Netherlands, CEMAGREF/France).

Salaries absorbed 83% of the total resources of the GDRS Research Division, while OCC amounted to around US\$ 3.3 million, i.e., an average of US\$ 16,200 per graduate staff member.

#### Research Activities and Linkages

Like GDAR, GDRS ARIs designed a research master-plan priority-assessment initiative which resulted in four major research priority areas: catchment management, soil management, water management and investment management, including research programs addressing the problems of water storage, irrigation, soil and water conservation, soil management, wastewater use, soil reclamation, irrigation and drainage management systems, and socioeconomic issues in land and water use.

In general terms, the research contribution of GDRS ARIs has been important in past development efforts of Turkish agriculture. However, such development efforts seem to have taken place unevenly throughout the country.

The GDRS research staff has had relatively more training opportunities than that of GDAR's. GDRS relationships with international institutions are improving; currently, research projects are being executed, at various scales, with ICARDA, IWMI, STOAS/Netherlands, CEMAGREF/France and Cranfield University/UK.

#### **The Research Institutes of the Ministry of Forestry (MOF)**

Eleven individual RIs, officially called Research Directorates, are coordinated by the Research, Planning and Coordination Council based at the MOF headquarters in Ankara. Of these institutes (see Table 4):

- one is a subject-specific RI: the Poplar and Fast Growing Tree Species RI (PFGTSRI), based in Izmir Kocaeli. It focuses on the improvement of *Populus*, *Salix* and *Eucalyptus* for planting on private land, rural construction, sawn timber, fuel, etc. It is also involved in developmental activities in connection with other institutions;
- one is a breeding RI: the Forest Tree Breeding and Seed Improvement RI (FTBSIRI), located in Ankara, which concentrates its activities on the improvement and multiplication of various forest tree species for use mainly in reclamation purposes; and
- nine are Regional Forest RIs: they are located in Ankara, Antalya, Tarsus, Izmir, Istanbul (Pendik), Bolu, Trabzon, Erzurum and Elazığ, and are responsible for forest research in the regions of Central Anatolia, west Mediterranean, east Mediterranean, Aegean, Marmara, west Black Sea, east Black Sea, Eastern Anatolia and Southeastern Anatolia, respectively. Their research activities cover silviculture, forest and soil protection, and forest products at the regional level; they involve close collaboration with regional representatives of various directorates, such as forest reclamation and erosion control, as well as international connections with various institutions (FAO, etc.).

The main mandate of these RIs is research (essentially adaptive) which mobilizes around 70% of the time of the scientific and technical graduate staff, the rest of their time being mostly devoted to development activities.

Currently, the MOF RIs employ 175 graduate staff members (including those at the headquarters), who represent 123 pRys. Human resources need improvement in terms of training, number, and balancing among the regions. Only 38% of the research scientists have postgraduate qualification (17 PhD, 49 MS), indicating the urgent need for training. The numbers of researchers are sufficient in institutions in the central, southern and western parts of the country, but those in the north and east suffer seriously from the lack of adequate numbers of researchers.

Forest RIs have no shortage of field resources for research since the state forests provide sufficient areas. Laboratory facilities have been improved in recent years, but equipment and information facilities in the RIs require modernization.

The estimated 1997 total budget of the Forest RIs was approximately US\$ 8.6 million (TL 1,330 billion), of which US\$ 7.6 million came from national sources, US\$ 0.9 million from the World Bank loan, and US\$ 83,300 from

<sup>1</sup> The total 1997 financial resources of the GDRS Research Division (with IAHRTC) amounted to US\$ 20.5 million, against US\$ 9.3 million in 1995.

other sources. The allocations for salaries and research were US\$ 7.1 million and 1.4 million, respectively. The US\$ 8,000 OCC allocation per researcher requires urgent improvement.

## 2.3 The Faculties of Agricultural Sciences (FASs)

### Overview (see Tables 6 and 7)

Presently, there are 19 Faculties of Agriculture (FOAs), 14 Faculties of Veterinary Medicine (FVMs), 9 Faculties of Forestry (FOF), and 10 Higher Schools and Faculties of Fisheries. Four new FOAs and 5 new FVMs are being established. Higher education institutions are scattered throughout the country. The main mandate of the FASs is undergraduate and graduate teaching; AR activities are implemented within the scope of their research and educational aims and the academic staff members are supposed to allocate 20 to 30% of their time to research-related activities, but the actual time devoted to these activities is much lower (see below).

All FOAs grant a BS degree (four years), the majority grant MS degrees, and a few grant also PhD degrees. About 25,000 undergraduate and approximately 6,000 graduate students are enrolled in the FOAs. A fully developed FOA would be composed of 13 departments<sup>1</sup>. The majority of the FOAs have fewer departments depending on the history of development, while four of the most developed faculties (Ankara, Erzurum, Izmir and Adana) have almost all the departments.

All FVMs grant a DVM degree (five years); five offer PhD programs. The FVMs host a total of 5,800 undergraduate and approximately 250 graduate students. They have three departments: veterinary basic sciences, animal breeding and nutrition, and animal diseases and clinic.

In 1997, the 52 FASs employed 3,360 graduate staff members, including 1935 academic staff members (academicians), all PhD holders, and around 1,425 young research assistants, most of them MS holders preparing for their PhDs, who usually act as support/technical staff for the former.

Almost all FASs have rather fair physical resources (lecture halls and rooms, tutorial labs and farms<sup>2</sup>, etc.), mainly adapted to their education mandate; however, these resources become more and more insufficient with the increase of student enrollment.

The FASs' estimated financial resources are approximately US\$ 40 million (TL 6,200 billion), of which US\$ 34 million (85%) are for salaries and US\$ 6 million (15%) for OCC (training and research), which means an extremely low average of US\$ 1,780 per academic staff member. However, these resources do not take into account the numerous research contracts funded directly by other NARS institutions in which academic staff members participate.

### Research Activities and Linkages

The availability of relatively highly qualified staff and of students, particularly those in the graduate study programs who are involved in research activities for their theses, offers large comparative advantages for the FASs to implement AR programs. However, research is constrained by many factors:

- Academic staff members with PhD degrees are appointed mainly for teaching. Their time available for research is rather limited because of the excessive teaching loads implied by the very large numbers of students. For example, in 1998, there were 215 academic staff members for almost 3,405 enrolled students, supported by 22 lecturers and 126 research assistants at the FOA of Ankara University, which has one of the best ratios (15.8) of students per academic staff member (data from Arli, M., personal communication). In most of the other FOAs, this ratio varies from 25 to 40 (see Tekinel et al., 1992).
- The lack of coherent policies for agricultural research. The FASs have no governmentally defined specific research responsibilities; they establish their own individual research policies and plans. Research policy decisions for universities are usually made at the faculty boards and departments as well as at the Turkish Scientific and Technical Research Council (STRCT). However, most of the research carried out is based on individual initiatives (either for the academicians' advancement purposes or for postgraduate theses) than for development of the agricultural sector.

<sup>1</sup> The standard, full-fledged FOA has the following 13 programs: soil science, farm structures and irrigation, field crops, horticulture, plant protection, animal husbandry, fisheries, landscape architecture, farm mechanization, food engineering, dairy technology, leather and fiber technology, agricultural economics.

<sup>2</sup> The majority of the FASs have a farm for student training, production, research, and, to some extent, for seed multiplication purposes; its size varies from 2 to 500 ha.

- Research resources are rather limited. Technicians are scarce (an average of only 0.25 technician per scientist) and mainly mobilized by the education activities. For most of the FASs, physical and financial resources are essentially allocated to training activities, and research facilities, equipment, and funds are considered insufficient, especially within the FASs established in recent years.
- The links with both the national ARIs and external educational and/or research institutions are not sufficiently strong and are limited to a few well-developed faculties.
- Due to the lack of effective linkage mechanisms, university research has little connection with farmers, development/extension organizations, and agricultural industries, though there are exceptions. Therefore, AR activities carried out at the FASs are often not of a problem-solving nature, and results often remain in publications and not readily available to users. The research activities and findings of Çurukova and Harran FOAs in Harran Plain through the Southeastern Anatolia Project (GAP: see below) may be considered as an exception, together with some others.

Due to these constraints, it is estimated that the FAS scientists may spend actually no more than 10% of their time on research-related activities. Thus, although the theoretical pRYs are 840 (using the normative ratio used for all the NARSs of the WANA region), the actual pRYs for the FASs would be around 340.

## 2.4 The Other Institutions Involved in Agricultural Research

The “other NARS institutions” are those in which AR activities cover a more or less small part of their mandate. They include some AR units managed by research or development institutions, many university institutions, and some public agro-industrial enterprises and development organizations.

### **Agricultural Research Units Managed by Research or Development Institutions**

Within this category, there are mainly the Scientific and Industrial Research Institutes of the Marmara Research Center (MRC), and the Nuclear Agricultural and Animal Research and Training Center (NAARTC):

- MRC, created in 1972 at Gebze/Kocaeli on 720 ha land belongs to STRCT. It executes research programs of high standard, with its 203 researchers, in a large span of domains: chemical, electronic, energy, mechanical, etc. It has two AR-related institutes: (i) the Institute of Genetic Engineering and Biotechnology (47 researchers: 25 PhD, 9 MS, 13 BS) specialized in molecular biology applied to agriculture and medicine, and (ii) the Institute of Food Technology (29 researchers: 9 PhD, 13 MS, 7 BS) specialized in advanced research in nutrition and food technology. The approximate annual budget for each of these two institutes is US\$ 3.5 million.
- NAARTC, based in Saraykoy-Ankara, run by the Turkish Atomic Energy Authority (TAEA, established in 1982), resulted from the merging in 1999 of two centers related to agricultural sciences: one for plant sciences and one for animal sciences, both in Ankara until recently. NAARTC conducts research for utilization of nuclear techniques in plant sciences and animal diseases. It currently employs 75 researchers (39 PhD, 31 MS, 5 BS) with a budget of US\$ 7 million (sum of the 1998 budgets of the two previous centers).

These research units have highly qualified researchers supported by comfortable financial resources and physical facilities of international standard.

### **University Institutions**

Most of the universities have, apart from their FASs, various units or departments covering disciplines related, one way or another, to agricultural sciences.

- Faculty Departments and Higher Schools: Biology is covered in the Faculties of Science, machinery in the Faculties of Mechanical Engineering, soil science in the Faculties of Geology, rural socioeconomic in the Faculties of Economics, rural geography in the Faculties of Arts or Education, and microbiology and nutrition in the Faculties of Medicine. Food science is also taught in several Food Engineering Faculties. Programs for fisheries are offered by several Higher Schools of Fisheries.
- The Institutes of Universities: Almost all universities have an “Institute of Sciences” which is responsible for the administration of postgraduate education. The postgraduate activities take place at related faculties, departments or institutes.

In addition to these Institutes of Sciences, some universities also have other institutes that conduct research and have research infrastructure, such as the Institute of Technology<sup>1</sup>, the Institute of Marine Sciences and Technology (9 September University) at Urla, Izmir<sup>2</sup>, and the Institute of Marine Sciences (IMS) at Erdemli, İcel (MET University)<sup>3</sup>.

Establishment of an accurate and complete inventory of these units is almost impossible since the activities of researchers in the same unit are diverse, some related to agriculture and some not. Thus, it is difficult to have a precise estimate of the total number of scientists concerned. However, a rough survey of some universities indicates that, at the national level, this number could be considered as 10% of the FASs<sup>4</sup>, which can be rounded to 340, representing 85 pRYs.

In these units, AR resources are rather limited and largely directed to scientists on an individual basis rather than through their institutions. However, these resources are certainly slightly higher than at the FASs, and the concerned scientists may actually spend around 15% of their time on AR-related activities, representing roughly around 40 actual pRYs.

### Research Institutes Affiliated to State Enterprises

State enterprises working on sugar beet, tea, and tobacco, have their own RIs that carry out significant research on their mandate crops, independently from GDAR, GDRS, and the university research sub-systems (see Table 5).

- The Sugar Beets RI of the Sugar Factories Enterprise, under the Ministry of Industry and Trade (MIT) - This unit employs (November 1998) around 29 researchers (of whom 20 are PhD or MS holders) and 30 permanent support staff, most of them located at the Ankara headquarters (with a number of stations in other locations). Its physical resources are satisfactory, except for information, communication and documentation resources which require strengthening. Its 1997 total budget was rather generous: US\$ 3 million, 65% of which was for salaries and 35% for OCC (about US\$ 48,000 per researcher).
- The Tea Institute of the ÇAYKUR Enterprise, under the Ministry of Finance and Customs (MFC) - This Institute, established in 1974, has (November 1998) 10 researchers (of whom 5 are PhD or MS holders) and 6 permanent staff. All research activities take place at the province of Rize (eastern part of the Black Sea coast) in the major tea-producing region. Field resources (5 ha) are adequate, but offices, laboratories and information resources require improvement. Its 1997 total budget amounted to US\$ 0.3 million, 15% for OCC, which means a poor US\$ 4,500 per researcher.
- The Monopole RI of the Monopole Enterprise, also affiliated to the Ministry of Finance and Customs - Its 24 researchers (of whom 4 are PhD or MS holders), 70 permanent support staff, and 76 temporary laborers are based at Istanbul. The physical resources are satisfactory but personnel capacity requires strengthening. The 1997 total budget was US\$ 2.9 million, 39% of which was for OCC (about US\$ 48,000 per researcher).

The three RIs account for 63 pRYs (63 full-time researchers) and US\$ 6.2 million financial resources.

### Agricultural Development Organizations

The major institution in this category is the Southeastern Anatolia Project (GAP), a regional development administration established in 1989 for the management of comprehensive socioeconomic development in the less developed southeastern region of Turkey. GAP aims to improve the living standards in the region by mobilizing the natural resources of the area, where an irrigated scheme for 1.7 million ha is being created. GAP is under the auspices of the Prime Ministry.

GAP carries out research activities in areas related to agriculture and rural development through its own staff or finances research projects prepared by other NARS institutions. It has 20 agricultural scientists in its Agricultural Department in charge of planning and implementing research and development projects. Its 1998 budget was US\$ 32 million, of which 5 % (approximately US\$ 1.5 million) was allocated for research activities.

<sup>1</sup> This Institute, established in the industrial town of Gebze in 1992, has extremely high standards of its capacity and resources, with 184 highly qualified academicians and 143 support staff. It covers various sectorial fields in various departments, including disciplines related to agriculture, such as biology, molecular biology, hydrobiology, and bioengineering.

<sup>2</sup> This Institute, established in 1975, has 61 academicians (48 PhD, 13 MS) and 45 support staff. Its research activities are carried out in marine biology and oceanography.

<sup>3</sup> This Institute (1975), which is part of the Middle East Technical University (METU), has 35 researchers with postgraduate qualifications working on marine biology (oceanography, ocean chemistry, ocean geology, marine products). Its facilities are modern and well established in Erdemli-İcel on the Mediterranean coast.



Recently, GAP has signed a collaboration agreement with ICARDA to implement joint projects and to develop a Regional Agricultural Research and Training Center in the GAP region.

### **3. AR RESOURCES**

#### **3.1 Human Resources**

Around 5,660 graduate and postgraduate staff members are working in the NARS (of whom 1,746 are in the public ARIs and 3,360 in the FASs), representing 2,288 pR Ys.

There is a serious imbalance between the level of academic training among the graduate staff of the FASs (all with PhD or MS degrees) and that of the ARIs affiliated to GDAR and MOF (42 and 38% with PhD or MS degrees, respectively), justified by the differences in salaries<sup>1</sup> and the past migration of the best-trained ARI researchers to the universities and the private sector. The proportion of PhD or MS holders (66%) at the GDRS Research Division is relatively better than at other public institutes. These differences result largely from differences in employment conditions in terms of salary, status, working environment and housing, which are better for the university staff and, to some extent, the GDRS staff than for MARA and MOF researchers who have employment conditions similar to administrative staff; this constitutes a major constraint to the development of AR within these two ministries.

The management of MARA research staff suffers other constraints and weaknesses. Staff stability has been limited due to transfers to other positions within or outside the MARA research system, regardless of the research programs under way. Consultation with RI directors on the recruitment of new staff for their institutes is limited, and the regulations which formerly provided a career-development structure within the research system is not functioning. Opportunities for improvement of status and salary are related to taking up administrative and managerial positions. These constraints are magnified in the less developed regions where living conditions are harsher than in other parts of the country, and where, until recently, no added compensation was offered for residing under these conditions. The situation for the MOF researchers is similar, although less severe and without the problem of frequent transfers.

Considering the large number of newly recruited researchers for GDAR and GDRS, it can be concluded that the number of research staff has reached a satisfactory level for many of their ARIs. However, in spite of the efforts during the last decade to train researchers (many young researchers received higher degrees and short-term training opportunities abroad within the framework of TARP), a major portion of the research staff is inexperienced and not adequately trained in general, particularly in some specific disciplines such as animal husbandry and breeding, forage crops, fisheries, and forest research.

As seen above, the high concentration of the NARS scientific potential in the developed regions of the country remains a challenge for the future.

In general, the number and quality of technicians are insufficient in almost all the NARS institutions due to the very low salaries offered by the public institutions and to the possibilities for technicians to prepare higher diplomas. This situation is a strong limiting factor for the scientists' research efficiency.

#### **3.2 Physical Resources**

In the majority of the ARIs of GDAR and GDRS, the state industrial enterprises, and developed academic and research institutions, research facilities (land, buildings, laboratories, etc.) are adequate both in quantity and quality, although strengthening in some institutions may be required in certain fields. The situation is less favorable in the other NARS institutions.

For the whole NARS, these facilities are considerable both in number and size (for instance, its farms total more than 40,000 ha), but are not well distributed in the country (relatively few in the underdeveloped regions). However, they constitute a huge set of separate units and infrastructures, the management and maintenance of which are very costly. Obviously, the situation could be rationalized and improved by gathering most of them in a small number of "campuses" (at least one per large region) accommodating critical masses of human and physical resources. This should allow providing common infrastructures and services (conference halls, library, communications, purchase offices, etc.) at a much lower cost and offering more opportunities for interaction and collaboration among scientists.

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<sup>1</sup> Average salary of researchers with a PhD and 10 years of professional experience is US\$ 400–500 at the ARIs and US\$ 1,000 at the universities.

However, having already established individual infrastructures for each institution, bringing them together on campuses would require enormous expenses and also strong political and bureaucratic support.

### 3.3 Financial Resources

In 1997, the total AR financial resources of the NARS (see Table 1) reached around US\$ 110.7 million, of which:

- US\$ 99.6 million came from national sources (governmental allocations and institutions' self-generated funds);
- US\$ 9.9 million loan from the World Bank;
- US\$ 1.2 million from external grants, mainly secured by a few donors (ICARDA, CIMMYT, IFAD, etc.).

National and total resources represent 0.36 and 0.40%, respectively, of the Agricultural Gross Domestic Product (AGDP, estimated at US\$ 28 billion in 1996). Such percentages are relatively low compared to the 1% ratio recommended by some international organizations (World Bank, European Union, etc.).

In most of the NARS institutions, salaries absorb the major portion of the budget, and at the GDAR, GDARS, and MOF ARIs, the available OCC per scientific and technical graduate staff member amounts to around US\$ 11,000, 16,000, and 8,000, which represents around US\$ 14,000, 19,500, and 9,700 per pRY, respectively<sup>1</sup>. Such OCCs are much under the "optimal" amount of US\$ 25,000–30,000 per RY used in the long-term plans designed by many developing countries, which means that the AR scientific potential is currently far from being fully mobilized.

According to this last reference, the GDAR, GDRS and MOF ARIs—the driving force of the Turkish NARS—would have roughly 460, 105, and 45 actual RYs (aRYs), respectively (as opposed to the 881, 143 and 123 pRYs estimated above), i.e., a sub-total of around 610 aRYs. However, as the capital costs currently needed are lower because of the large investments made under TARP in recent years, it is reasonable to assume that this sub-total may reach (roughly) around 700 aRYs.

Adding the rounded 580 aRYs estimated for the other institutions of the NARS<sup>2</sup>, the NARS would total around 1,280 aRYs, against 2,288 pRYs estimated above.

It is worth mentioning that the US\$ 9.9 million loan provided by the World Bank in 1997, allocated mainly to OCC, may provide research resources for around 360 aRYs. This indicates that the current mobilization of AR scientific potential strongly relies on external loans/funds and, for sustainability of this mobilization, alternative resources will be necessary in the near future.

Such global estimates are not available for previous years; however, referring to the evolution of the resources of GDAR and some other NARS institutions, it seems that since the early 1990s:

- government funds for AR have been declining;
- this decrease has been compensated for by the availability of the World Bank loans, the increase of the institutions' self-generated funds, and the utilization of other funding options.

As the World Bank loans will be available for only another two years, prospects are not very bright. The recent evolution brings out the problem of sustainability of adequate funding for the medium term.

It is also worth mentioning that the governmental NARS institutions are all governed according to the regulations applicable generally across the state sector, and have little flexibility for research administrators in resource development and management. Such initiatives would require enormous bureaucratic procedures that would discourage researchers and administrators from taking such actions. The constraints in personnel management regulations are also reflected in financial matters. The regulatory weakness of administrators in arranging personnel recruitment and transfer results in ineffective use of financial resources.

Revolving funds of the institutions (strong in some) are very useful for some operational expenses, but regulations do not allow enough flexibility (for example, purchase of capital items and turnover from year to year are not allowed) for utilization of these funds. Other funding options at national and international levels have been realized as alternative

<sup>1</sup> OCC per pRY is higher than OCC per graduate staff member as the number of pRYs is lower than the number of graduate staff members and part of the OCC is allocated to other activities than research (see Table 1, note j).

<sup>2</sup> 10 aRYs at AERI, 128 aRYs at the MRC Institutes and NAARTC/TAEA, and 15 aRYs in GAP (all institutions where OCC is high or sufficient and aRYs are equal to pRYs); 340 aRYs at the FASs (see Section 2.3); 40 aRYs at the university institutions; and around 50 aRYs at the RIs of the Industrial State Enterprises (see Section 2.4).

sources, but little progress has been made, mostly at a few developed institutions. This is expected to improve in the future, though not rapidly, together with human resource development efforts. A significant improvement can be made for securing financial resources through: (i) increasing public and political awareness of AR, resulting in allocation of more funds from the central governmental budget, not only for salaries of the employees, but also for operational expenses of research projects; (ii) establishment of a research project and funding philosophy based on demand-driven research activities, i.e., projects should be financed by the end users; and (iii) in connection with item (ii), little and applicable amount of levy may be charged to produce sold, at least to the state or cooperatives, and transferred to research funds.

## 4. RESEARCH ACTIVITIES AND LINKAGES

### 4.1 Research Activities

In the near past, the funding process for most of the research carried out by the GDAR, GDRS and MOF research institutions and the universities was not based on systematically determined research priorities at the national level. As a result, there were too many small under-funded projects that tended to be discipline-based and duplicative in some cases. However, there were some exceptions, the most well-known example being the large Coordinated National Commodity Research Projects within GDAR for some major crops such as wheat and pulses. Some of these national projects are still ongoing and are expected to be replaced by newly designed larger research programs.

With the implementation of TARP, both GDAR and GDRS developed research master plans that established formal priority-setting mechanisms for their research agendas and set up systematic national, multidisciplinary, multi-institutional research programs for all research activities and topics. Similarly, some FASSs have started to establish research priority areas. At the national level, the Agriculture and Forestry Group of the STRCT has recently proposed priority AR areas in remote sensing, development of more efficient irrigation techniques, quality and resistance breeding for major crops, fertilizer-use efficiency and crop nutrition, novel tillage and mechanization techniques, pesticide residue issues, integrated pest management (IPM), post-harvest physiology, database development for agriculture, soil conservation and range amelioration, biotechnology, and food technology.

In general, these national research programs have given high attention to biological and physical sciences, with some questionable sub-emphasis on animal husbandry, pasture improvement and fisheries. For a long time, rural socioeconomic research has been marginalized (there are still a few trained economists and almost no social scientists within the ARIs), and its contribution to the national research program has been very little; the recent establishment of AERI within MARA offers new prospects.

### 4.2 Linkages with Development

In recent years, within the framework of the Agricultural Extension and Applied Research Project (AEARP), linkages between some GDAR ARIs and farmers have been established through on-farm research activities in the project area and through the creation of a Research-Extension Liaison Department in some of the ARIs. The recent establishment of extension and training departments at the central ARIs of GDAR is expected to strengthen the linkage between the ARIs and extension units.

However, linkages with development institutions and end users require further strengthening. The Extension Service, farmers' unions, and cooperatives<sup>1</sup> are not represented in the directive boards of the NARS institutions and were not actually involved in their research priority setting, planning, implementation, and evaluation of research activities. Therefore, contribution of the farmers as organized bodies to the NARS research activities is not satisfactory due to insufficient liaison and this has to be improved in order to enhance the strength of the AR system.

Increased support and incentives for scientists to undertake collaborative research with other institutions or entities that have complementary skills, facilities, and common interests, would encourage better linkages. The recently established Local Area Network (LAN) and WAN (Wider Area Network) at GDAR and those considered for the GDRS research system will help enhance linkages and communication among research institutions.

<sup>1</sup> Farmers' cooperatives and similar organizations are government-controlled and operated, and independent producers' associations or cooperatives do not exist.

### 4.3 International Linkages

The international connection of the Turkish NARS has grown very strong through the support of the World Bank and FAO for execution of various research and development projects. Collaboration with international AR centers has been intensified in the last decade, especially with CIMMYT and ICARDA, and the resulting establishment of the International Winter and Facultative Wheat Improvement Program (IWWIP) could be considered as a model of international collaboration which would be highly profitable for all partners involved.

International relationships are also being strengthened with CIHEAM. Bilateral cooperation is growing rapidly with the neighboring Central Asian Republics of the former Soviet Union and with the north and south Mediterranean countries (mainly through CIHEAM and ICARDA), but remain insufficient with other developed countries.

## 5. CONCLUSION

Currently, the Turkish NARS is made up of a large number of research, academic, and technical institutions governed by several ministries and universities. Due to the large size of GDAR, which mobilizes 55% of the financial resources of the NARS, it may be considered as rather "institutionally" or "structurally" concentrated. However, the overall fragmentation of the NARS makes it difficult to allocate and administer the resources effectively. The efficiency of coordination of research activities within and outside research organizations is required for avoiding or limiting the overlapping of responsibilities and duplication of research efforts.

The NARS is endowed with human, physical, and financial resources, which appear, at first glance, important, but actually suffer several weaknesses:

- Most of the research institutions are constrained by the academic level of the graduate scientific staff, still insufficient in spite of the recent training efforts, and by the lack of adequate incentives for research scientists, staff instability, and understaffing in less developed regions. In all institutions, technicians are too few and are strongly limiting the efficiency of the scientists.
- Physical resources are huge and, globally, rather good, but the excessive fragmentation of the infrastructures results in high costs for their management and maintenance, and for communication and collaboration between scientists.
- Almost all AR organizations are funded by a general government budget. The major part of the government allocation goes to salaries. Research funds are not sufficient due to financial constraints, especially for operational and capital costs. This situation prevails even at GDAR and GDRS which benefit from a large World Bank loan. Therefore, the NARS scientific potential is far from being fully utilized.

The implementation of TARP has produced very positive changes in the research activities at GDAR and GDRS by promoting multidisciplinary and multi-institutional research programs. This was achieved by focusing the available resources, through their master plans, on priority research programs and directing the use of these resources properly through concentrating on fewer ARIs which possess better prospects for development. In the long run, other changes are expected to induce investment increases in AR, development of more effective organizations and management systems, improvement of effective use of research resources, improvement of collaboration among NARS institutions, and strengthening linkage mechanisms between research and extension.

Turkey is experiencing a rapid transformation from an essentially rural society to a mainly urban and industrial one. Yet, nearly 40% of the population is engaged in agricultural production. Its agriculture has wide agroecological diversity and large natural resources (land, water, genetic resources). The country is self-sufficient on a large scale; however, increasing productivity is essential for meeting the food needs of the fast-growing population (2.3% annually) and to take advantage of the emerging agro-industries and export opportunities. Such objectives can be achieved through sustainable and efficient use of these resources and improved agricultural technologies. Thus, AR is of vital importance to the nation. Historically, AR carried out in the past has made significant contributions to innovation and technical change in Turkish agriculture. The future challenge could be met only through acceleration of the structural changes implemented by TARP and also by a significant increase of the financial resources through a much-expanded public investment and through non-governmental sources.

## Main Acronyms

**MARA:** Ministry of Agriculture and Rural Affairs. **MOF:** Ministry of Forestry. **GAP:** Southeastern Anatolia Project. **TARP:** Turkish Agricultural Research Project. **STRCT:** Scientific and Technical Research Council of Turkey.

**GDAR:** General Directorate of Agricultural Research. **GDRS:** General Directorate of Rural Services. **RI:** Research Institute. **FOA:** Faculty of Agriculture.

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**Table 1 - The National Agricultural Research System (1997/98)\***

\* Most of the human resources: 1998, most of the financial resources: 1997. *Italics*: Approximate data. ... Data not available. \* See footnotes

NARS Institutions				AR Scientific & Techn. Graduate Staff* (Units)		AR Potential Res. Years	Total Budget (million US\$)		AR Expenditures/Resources (E) (million US\$)				
No.	Name - Head Office Acronym - Year Established	Mandates AR Fields	Govern. Ministry	Total - (PhD, MS)			Nat.	Ext.	Nat. NE	Loan LE	For. FE	Total TE	
a	b	c	d	e	f	g	h	i	j	k	l	m	
1.2	General Directorate for AR (55 ARIs) Ankara (see Table 2)	GDAR 1991	AR (55%) - (AD) All (except 2.2, 2.3, forest...)	MARA	1355	265, 310	881	66.7	5.9	55	5	0.9	60.9
2.2	Agricultural Economics RI - Ankara	AERI, 1996	AR (30%) - Ag. Eco	MARA	12	4, 2	10	0.1	1	0.1	1	1	1
2.3	Research Division, General Dirctet. for Rural Services (11 RIs) - Ankara (see Table 3)	GDRS 1993	AR (70%) - (AD) Soil, water, ...	PM	204	35, 100	143	16.4	3.2	13.9	3	0.2	17.1
2.4	Forestry RIs (11 RIs) Ankara (see Table 4)	1952	AR (70%) - (AD) - Forestry	MOF	175	17, 49	143	7.6	1	6.5	0.9	0.1	7.5
1-2	Total Agricultural Research Institutes				1746	305, 479	1157	90.7	11.1	75.4	9.9	1.2	86.5
3.1	19 Faculties of Agriculture (see Table 6, 7)	FOA, 1933-...	AHE - (AR)	MHE	1957	1195, 761	489	21.1					
3.2	14 Faculties of Veterinary Medicine (see Table 6, 7)	FVM, 1842-...	AHE - (AR)	MHE	898	483, 415	224	9.8					
3.3	8 Faculties of Forestry (see Table 6, 7)	FOF, 1933-...	AHE - (AR)	MHE	240	143, 97	60	2.9					
3.4	10 Faculties of Fisheries (see Table 6, 7)	FF, 1965-...	AHE - (AR)	MHE	265	113, 152	67	4.5					
3	Total Faculties of Agricultural Sciences				3360	1935, 1425	840	38.3	...	3.8	...	3.8	
4.1	Marmara Res. Center Scient. & Indust. Res. Inst.*	MRC - 1972	R (AR)	STRCT	53	22, 18	53	5.1	...	5.1	...	5.1	
4.2	Natl. Ag. & Anim. Res. & Train. Centre, TAEA*	NAARTC - 1999	AR	PM	75	39, 31	75	7	...	7	...	7	
4.3	Other University Institutions (see Section 2.4)		HE - (R/AR)	MHE	349	260, 150	85	...	...	0.6	...	0.6	
4.4	Indust. Enterprises (3 AR institutes) (see Table 5)*	1927-74	AR - Sugar, tea, tobacco	MIT, MFC	63	29*	63	6.2	...	6.2	...	6.2	
4.5	Southeastern Anatolia Project*	GAP, 1989	AD - (AR) All	PM	20	...	15	*	...	1.5	...	1.5	
4	Total Other Institutions				551	...	291	...	...	20.4	...	20.4	
5	Total NARS				5657	...	2288	...	...	99.6	9.9	1.2	110.7
Exchange Rate: US\$ 1 = 156,000 Turkish Lira (TL) (1997 average rate)					Actual Research Years (aRY) (Estimate) ---->		1280						

MARA: Min. of Agriculture and Rural Affairs; MFC: Min. of Finance and Customs; MHE: Min. of Higher Education; MIT: Min. of Industry and Trade; MOF: Ministry of Forestry; PM: Prime Minister; STRCT: Scientific and Technical Research Council of Turkey

c. **Mandates**: AR (..) % Approximate average % of human resources devoted to ag. research (AR). R: Research; AHE: Ag. higher education; AD: Ag. development/services (for AR and AHE institutes: seed production, soil and water analysis, extension, studies, etc.) g. Potential research year (pRY) = equivalent full-time researcher; for the FAs, the pRYs have been estimated by multiplying the number of academic staff by 0.25 j. For the AR institutes, AR financial resources have been roughly estimated through the following formula: Total budget \* [(a - 0.5(100% - a))], or being the % of time devoted to AR by the graduate staff.

\*Notes: e, f. All the AR scientific and technical graduate staff members are national. 4.1. Marmara Research Center Scientific and Industrial Research Institutes (MRC, Gebze/Kocaeli, with its Institute of Genetic Engineering and Biotechnology and its Institute of Food Technology (see Section 2.4). 4.2. Turkish Atomic Energy Authority (TAEA, Ankara). 4.4. Sugar Beet RI (Sugar Factories Enterprise/MIT, Ankara), Tea Institute (ÇAYKUR Enterprise/MFC, Rize), Monopole RI (Monopole Enterprise, Istanbul), 29 PhD or MS holders. 4.5. The GAP total 1998 budget is US\$ 32 million. 4.1, 4.2, 4.3, 4.4. Only the human and financial resources allocated to AR are mentioned.

National AR expenditures (NE) = 0.36% of the AGDP (US\$ 28 billion in 1996) Total AR expenditures (TE) = 0.40% of the AGDP

**Tab. 2 - The GDAR Agricultural Research Institutes**

GDAR Research Institutes					Scientific & Techn. Graduate Staff (Units)	
No	Name	Head Office	Year Estab.	Mandates % AR* - AR Fields	Total	PhD or MS holders
A 1	Central Res. Inst. for Field Crops (CRIFC)	Lodumlu/Ankara	1986	Field crops	73	26
A 2	Atatürk Central Hort. Res. Inst (ACHRI)	Yalova/Istanbul	1961	Horticulture	43	25
A 3	Central Livestock RI	Lahana	1937	Livestock	25	0
A 3	Central Food Technology RI	Bursa	1961	Food technology	36	11
A 5	Central Plant Protection RI	Ankara	1987	Plant protection	51	11
A 6	Central Veterinary Control and RI	Etilik/Ankara	1921	Animal health	91	28
A 7	Central Fisheries RI	Trabzon	1987	Fisheries	29	8
Total 7 Central AR Institutes					348	109
B 1	Cukurova Agricultural Res. Inst (CARD)	Adana	1961	Various	35	14
B 2	Mediterranean ARI	Aksu/Antalya	1935		31	10
B 3	Southeastern Anatolia ARI	Diyarbakir	1962		12	7
B 4	Thrace ARI	Edirne	1970		17	16
B 5	Eastern Anatolia ARI	Erzurum	1969		29	12
B 6	Anatolian ARI	Eskişehir	1925		31	17
B 7	Aegean ARI	Menemen/Izmir	1963		48	41
B 8	Black Sea ARI	Samsun	1944		34	10
Total 8 Regional AR Institutes					242	189
C 1	Bahri Dagdas Intern. Wint. Cereals R.C.	Konya	1987	Winter cereals	13	5
C 2	Cotton Res. Inst.	Nazilli/Aydin	1987	Cotton	24	17
C 3	Sakarya Agricultural Res. Inst.	Sakarya	1925	Cereals	11	2
C 4	Horticultural Res. Inst.	Erdemli/Icel	1969	Horticulture	34	20
C 5	Horticultural Res. Inst.	Erzurum	1987	Horticulture	21	5
C 6	Fruit Res. Inst.	Malatya	1987	Fruit	13	0
C 7	Citrus (Green House) Res. Inst.	Antalya	1994	Fruit	91	24
C 8	Hazelnut Res. Inst.	Giresun	1936	Hazelnut	7	2
C 9	Olive Res. Inst.	Bornova/Izmir	1987	Olive	27	26
C 10	Viticulture Res. Inst.	Manisa	1930	Viticulture	13	10
C 11	Viticulture Res. Inst.	Tekirdag	1936	Viticulture	13	12
C 12	Pistachio RI	Gaziantep	1987	Pistachio	13	5
C 13	Fig Res. Inst.	Erbeyli/Aydin	1936	Fig	12	3
C 14	Potato Research Institute	Nigde	1995	Potato	7	1
C 15	Horticulture RI	Egirdir/Isparta	1987	Horticulture	21	3
C 16	Haran ARI	Akcaale/Surfa	1987	Cotton +	5	3
C 17	Kahramanmaraş ARI	Kahramanmaraş	1972	Cotton +	19	0
C 18	Islahiye Agr. Res. Inst.	Islahiye/G. Antep	1998	Viticult/Olive		1
Total 18 Subject AR Institutes: Plant Breeding and Agronomy					332	150
D 1	Plant Protection Res. Inst.	Adana	1931	Plant protect.	35	25
D 2	Plant Protection Res. Inst.	Bornova/Izmir	1931	Plant protect.	34	41
D 3	Plant Protection Res. Inst.	Diyarbakir	1956	Plant protect.	15	3
Total 3 Subject AR Institutes: Plant Protection					84	69
E 1	Livestock RI	Konya	1937	Livestock	25	5
E 2	Mohair Goat RI	Yedigözü/Yozgat	1942	Livestock	3	0
E 3	Kocatepe ARI	Afyon	1962	Livestock +	2	1
E 4	Poultry RI	Ankara	1935	Poultry	19	2
E 5	Marmara Livestock RI	Bandirma/Balıkesir	1936	Livestock/Sheep	7	3
E 6	Senecultural RI	Bursa	1998	Silk	21	1
E 7	Apiculture RI	Ordu	1995	Apiculture	5	1
E 8	Leather RI	Kartal/Istanbul	1971	Leather	8	2
Total 8 Subject Research Institutes (GDAR) Animal Husbandry and Breeding					97	14
F 1	Veterinary Control and RI	Adana	1964	Animal health	17	2
F 2	Veterinary Control and RI	Samsun	1957		8	
F 3	Veterinary Control and RI	Elazığ	1952		24	0
F 4	Veterinary Control and RI	Erzurum	1970		7	3
F 5	Veterinary Control and RI	Konya	1956		13	3
F 6	Veterinary Control and RI	Pendik/Istanbul	1914		34	11
F 7	Veterinary Control and RI	Bornova-Izmir	1953		24	19
F 8	Poultry Diseases & Vaccine Prod. Inst.	Manisa	1962		13	2
F 9	Foot & Mouth Disease Inst. (FMDI)	Ankara	1967		22	10
Total 9 Subject Research Institutes: Animal Disease					166	65
G 1	Fisheries Res. Inst.	Egirdir/Isparta	1986	Fisheries	21	3
G 2	Fisheries Res. Inst.	Bodrum/Mugla	1987		22	10
Total 2 Subject Research Institutes: Fisheries					43	17
H	General Directorate-Headquarter	Ankara	1991		53	30
Total 55 GDAR Research Institutes				65% *	1355	575

Newly founded Islahiye RI is excluded in calculations. \*: Average % of the graduate staff members' time allocated to AR.

**Table 3 - The GDRS Agricultural Research Institutes**

GDRS Research Institutes						Scientific & Technic. Graduate Staff (Units)	
No.	Name	Head Office	Year Estab.	Mandates		Total	PhD or MS holders
				% AR* -	AR Fields		
1	Rural Services Research Institute	Ankara	1962	Soil, irrig., fertiliz.		30	27
2		Erzurum	1979			19	7
3		Eskisehir	1953			12	7
4		Kirkareli	1981			13	8
5		Konya	1985			13	7
6		Menemen	1947			21	16
7		Samsun	1979			15	12
8		Sanliurfa	1976			13	13
9		Tarsus	1947			9	3
10		Tokat	1963			13	2
11	Soil and Fertilizer Res. Inst.	Ankara	1953			29	17
	Headquarte- Research Division, RPCD	Ankara	1993			13	7
Total 11 GDRS AR Institutes				70% *		213	135

GDRS also governs the International Agro-hydrology Research and Training Center (Izmir-Menemen, created in 1996; 9 researchers, of whom 6 are PhD and MS holders), which is not fully part of the NARS. \*: Average % of the graduate staff members' time allocated to AR (same for the following tables).

**Table 4 - The Research Institutes affiliated to the Ministry of Forestry**
*Italics: Approximate numbers.*

RIs of the Ministry of Forestry						Scientific & Technic. Graduate Staff (Units)	
No.	Name	Head Office	Year Estab.	Mandates		Total	PhD or MS holders
				% AR* -	AR Fields		
1	Poplar & Fast Grow. Forest Sp. RI (PPGFSRI)	Kocaeli, Izmir	1962	Forestry		42	12
2	Forest Tree Breeding & Seed Improv. RI	Ankara	1964			18	7
3	Central Anatolia Forest RI	Ankara	1992			33	7
4	West Mediterranean For. RI	Antalya	1953			14	8
5	Eastern Mediterranean For. RI	Tarsus	1992			3	3
6	Agan Forestry RI	Bornova-Izmir	1977			25	13
7	Marmara Forestry RI	Istanbul	...			7	3
8	Western Black Sea Forestry RI	Bolu	...			3	2
9	Eastern Black Sea Forestry RI	Trabzon	...			8	3
10	Eastern Anatolia Forestry RI	Erzurum	...			3	1
11	Southeastern Anatolia Forestry RI	Elazir	...			7	1
	Research Division, RPCD, Headquarter	Ankara				8	6
Total 11 GDRS AR Institutes				70%		171	64

**Table 5 - The Public Enterprise Research Institutes**

Agricultural Research Institutes of Public Enterprises						Scientific & Technical Graduate Staff (Units)	
No.	Name	Head Office	Year Estab.	Ministry	Mandates AR Fields	Total	PhD or MS holders
1	Sugar Res. Institute	Ankara	1937	MIT	Sugar beet	29	20
2	Tea Research Institute	Rize	1974	MFC	Tea	10	5
3	Monopole Research Institute	Istanbul	1927	MFC	Tobacco	24	4
Total 3 ARIs of Public Enterprises						63	29

MIT: Ministry of Industry and Trade, MFC: Ministry of Finance and Customs.

**Table 6 - General Overview of the Faculties of Agricultural Sciences**

FASs	Academic Staff							Number of Students				Students /Staff	1997 National Budget (US\$ million)*
	Distribution of Staff in Terms of Titles					Total	Under-graduate	MS	PhD	Total			
	Full Prof	Assoc. P	Asst. P	Others	With PhD						Without PhD		
19 FOAs	443	198	291	1025	1196	761	1957	24467	2871	1489	28827	14.7	21.1
14 FVMs	139	122	143	494	483	415	898	5835	179	941	6955	7.7	9.8
8 FOFs	59	28	24	157	143	97	240	3095	378	124	3597	15	2.9
10 FFs	32	13	34	186	113	152	265	2479	292	188	2959	11.2	4.5
All FASs	673	361	492	1862	1935	1425	3360	35866	3720	2742	42338	12.6	38.3



**Table 7 - The Faculties of Agricultural Sciences:**  
Agriculture (FOA), Veterinary Medicine (FVM), Forestry (FOF), Fisheries (FF)

Faculties of Agricultural Sciences						Graduate Staff (Units)	
No.	Faculty	Location	University	Year Estab.	Diplomas delivered	Total	PhD holders
1	FOA	Ay din	Adnan Menderes	...	...	56	35
2		Antalya	Akdeniz	1984	...	56	37
3		Ankara	Ankara	1930	...	374	257
4		Erzurum	Atatürk	1958	...	152	107
5		Çanakkale	Çanakkale	...	...	17	3
6		Adana	Çukurova	1967	...	229	164
7		Diyarbakır	Dicle	...	...	16	5
8		İzmir	Ege	1958	...	259	181
9		Tokat	Gaziosmanpaşa	1982	...	135	61
10		Urfa	Harran	1981	...	62	28
11		Kahramanmaraş	Kahramanmaraş	1985	...	56	14
12		Trabzon	Karadeniz T.Ü.	...	...	17	5
13		Hatay	Mustafa Kemal	...	...	44	28
14		Samsun	Ondokuz Mayıs	1976	...	98	50
15		Konya	Selçuk	1982	...	92	37
16		İsparta	Süleyman Demirel	...	...	26	14
17		Tekirdağ	Trakya	1982	...	120	72
18		Bursa	Uludağ	1981	...	115	62
19		Van	Yüzüncü Yıl	1982	...	92	33
A	Total 19 Faculties of Agriculture					1957	1196
1	FVM	Ay din	Adnan Menderes	...	...	43	15
2		Burdur	Akdeniz	...	...	16	6
3		Ankara	Ankara	...	...	171	115
4		Diyarbakır	Dicle	...	...	12	3
5		Kayseri	Erciyes	...	...	10	1
6		Elazığ	Firat	...	...	132	77
7		Urfa	Harran	...	...	23	3
8		İstanbul	İstanbul	...	...	63	42
9		Kars	Kafkas	...	...	98	39
10		Konya	Selçuk	...	...	92	60
11		Bursa	Uludağ	...	...	93	55
12		Van	Yüzüncü Yıl	...	...	79	42
13		Afyon	Afyon Kocatepe	...	...	44	14
14		Kırıkkale	Kırıkkale	...	...	10	9
B		Total 14 Faculties of Veterinary Medicine					898
1	FOF	Abant İzzet Baysal	Bolu	...	...	19	8
2		Ankara	Ankara	...	...	5	2
3		İstanbul	İstanbul	...	...	79	61
4		Kafkas	Kars	...	...	26	13
5		Kahramanmaraş	Kahramanmaraş	...	...	27	5
6		Karadeniz T.Ü.	Trabzon	...	...	61	41
7		Süleyman Demirel	İsparta	...	...	12	2
8		Zonguldak Karacelmaz	Zonguldak	...	...	17	14
C		Total 8 Faculties of Forestry					240
1	FF	Çanakkale	Çanakkale 18 Mart	...	...	9	8
2		Adana	Çukurova	...	...	12	9
3		İzmir	Ege	...	...	93	53
4		Elazığ	Firat	...	...	31	10
5		İstanbul	İstanbul	...	...	42	18
6		Trabzon	Karadeniz T.Ü.	...	...	11	4
7		Mersin	Mersin	...	...	8	2
8		Hatay	Mustafa Kemal	...	...	2	0
9		Samsun	Samsun 19 Mayıs	...	...	26	8
10		İsparta	Süleyman Demirel	...	...	31	11
D	Total 10 Faculties of Fisheries					265	113
E	Total Agricultural Sciences Faculties (A + B + C + D)					3360	1935

## **8. MONOGRAPHS OF THE NATIONAL AGRICULTURAL RESEARCH SYSTEMS OF THE ARABIAN PENINSULA**

**BAHRAIN**

UNITED ARAB EMIRATES

YEMEN



# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF BAHRAIN<sup>1</sup>

## 1. HISTORICAL BACKGROUND

Agricultural research (AR) in Bahrain started in the mid-1930s under the British Protectorate. The location of the activities was along the northwest coast of the main island, in Budaiya, where the current Experimental Station is situated. During the 1960s, these activities developed into the Department of Municipality and Agriculture, which became the Ministry of Municipality and Agriculture in 1971, at the time of independence. After reorganizing the ministries in 1975, agriculture was joined to the Ministry of Commerce and Agriculture (MCA) and was overseen by the Directorate of Agriculture, later (1985) transformed into the Agricultural Affairs, consisting of several directorates and a section for research. In 1991, the Research Section was upgraded into the Agricultural Research Directorate (ARD), affiliated to MCA, then, in 1995, to the Ministry of Works and Agriculture (MWA).

The Fisheries Directorate was founded in 1979 by MCA for assessing and reviewing specific aspects of Bahraini fisheries.

Most of the other institutions which currently conduct AR activities as a minor part of their mandate have been created during the 1980s: (i) Al-Areen Wildlife Park (AWP), created during 1976–1979, now affiliated to the Ministry of Cabinet Affairs and Information; (ii) the Environmental Affairs (1981), now under the Ministry of Housing, Municipalities and Environment; (iii) the Bahrain Center for Studies and Research (BCSR, 1981), for coordinating scientific efforts at the national level and for conducting or supporting research in some domains (mainly in economics); (iv) the College of Applied Sciences of the Arabian Gulf University (1986), through its Program for Desert and Arid Zones Sciences; and (v) the Department of Biology (1986) of the College of Science of the University of Bahrain, under the Ministry of Education.

## 2. THE CURRENT NARS

### 2.1 Overview (see Table 1)

The current NARS is made up of two sets of institutions:

- The institutions mainly involved in AR: the Agricultural Research Directorate and the Fisheries Directorate, both affiliated to MWA; together they account for about 66% of the potential research years (pRys: equivalent full-time researchers) and 73% of the total financial resources of the NARS. They are presented in Section 2.2.
- The other institutions that currently conduct AR activities as a minor part of their mandate (listed above): they mobilize the remaining resources of the NARS and are presented in Section 2.3.

There is no body responsible for the national AR policy. However, the Bahrain Center for Studies and Research (BCSR) is mandated with coordinating scientific efforts at the national level.

### 2.2 The Agricultural Research Institutions

#### The Agricultural Research Directorate (ARD)

ARD, a directorate within MWA, is by far the largest and most active AR institution in the NARS (34% of the pRys and 47% of the total financial resources). Its main mandate (which mobilizes around 75% of the time of its graduate staff) is on applied research in plant production, date palm and ornamentals, soil and water, animal and fodder, and economics/statistics. Other activities cover technology transfer (expertise and support for extension) and services (production of seeds and seedlings, soil, water, food and feed analysis).

ARD employs 15 graduate staff members, of whom 7 are nationals (3 MS, 4 BS) and 8 expatriates, who represent around 11 pRys<sup>2</sup>. It also has 25 permanent national technicians and 85 other support staff (clerks, laborers, etc.).

<sup>1</sup> By **Dr Al-Khalifa Mohamed Abdel-Wahab**, Director, Agricultural Research Directorate (ARD); **Dr H.A. Al-Sayed**, Department of Biology, College of Science (Bahrain University); **Dr J. Al-Sheikh**, Al-Areen Wildlife Park (AWP), **Dr M.A. Hassan**, Environmental Affairs; and **Dr A. Khater**, Bahrain Center for Studies and Research (BCSR).

<sup>2</sup> pRys = Number of graduate staff members × 75% (average percentage of their time allocated to AR).

ARD physical facilities consist mainly of

- Laboratories at Budaiya that are equipped with most of the required equipment and chemicals, including the soil and water laboratory which carries out a range of analyses on both soil and plant material, and the laboratory and growing facilities devoted to micro-propagation.
- Two experiment stations: one at Budaiya (20 ha), including plastic tunnels and a nursery to produce healthy seedlings for open field and protected vegetables, and fruit and ornamental trees; and one at Hamala (45 ha) for livestock (emphasis on testing/crossing breeds of sheep, goats and cattle suitable for the Bahraini climate and needs), endowed with a fully mechanized fodder production unit with modern agricultural machines.

The current ARD financial resources (1996) amount to about Bahraini dinars (BD) 630,000 (US\$ 1.67 million), coming from allocations from the national budget; 77% cover staff costs, the remaining to operating and capital costs (OCC), which means an average of US\$ 25,600 per graduate staff member.

Research efforts focus mainly on open field and protected vegetables, new cash crops, and fish production. Date palm and permanent fruit crops are insufficiently covered. Forage crops, livestock, and rural socioeconomics require more effort and support.

ARD has good relations with other national institutions (BCSR; DB/CS). International linkages are rather well developed, especially with ICARDA (cereals, legumes and more recently through the Arabian Peninsula Program protected agriculture and natural resource management), Japan (animal husbandry), and AOAD.

### **The Fisheries Directorate (FD)**

FD is responsible for the assessment and management of the marine resources in Bahrain. Its objectives are to develop the sector, protect fish and marine resources, and introduce commercial mariculture to Bahrain. The Directorate also conducts surveys and produces statistical reports which reflect the status of the Bahraini fisheries. As such, it is involved in a diverse range of activities. Research mobilizes around 70% of the time of its graduate staff.

It has 15 scientists, of whom are 12 nationals (2 PhD, 3 MS, 7BS) and 3 expatriates, who represent 10 pRys. Its financial resources (1996) amount to about BD 370,000 (US\$ 0.98 million) coming from the national budget; 83% go to staff costs and 17% to OCC (US\$ 11,100 per graduate staff member).

Research activities cover mariculture as well as marine environmental issues. They involve collaboration with Japan which provides some expatriates and training for nationals.

## **2.3 The Other NARS Institutions**

### **The Other NARS Scientific Institutions**

The Biology Department, College of Science (Bahrain University) - This unit, which is one of the major departments of the College of Science, offers BS courses (lasting 4 years) and other degree courses to a relatively small number of students. It is engaged in education and research in different fields related with plant, animal, and marine biological, microbial, genetic and environmental sciences. It has 9 academic staff members (2 professors, 3 associate professors, 4 assistant professors), of whom 6 are national. They account for around 3 pRys.

The Program for Desert and Arid Zones Sciences (DAZ), College of Applied Sciences (Arabian Gulf University) - This unit is mainly involved in postgraduate studies leading to a Diploma/MS<sup>1</sup>. Research projects prepared by the students cover areas of utmost interest to the region: desert resources, desert agriculture, resource management and its impacts on desert environment and groundwater resources in the Gulf region, pollution of the Arabian Gulf environment, desert architecture and energy. DAZ stresses the use of modern technologies, including geographic information systems, remote sensing and networking, as important tools for assessment, monitoring and planning of development and conservation of desert resources. DAZ has 8 highly qualified academic staff: 4 nationals and 4 expatriates, 2 of them concerned with AR (2 pRys).

<sup>1</sup> 40 students have been awarded MS degrees during the last decade, including a large number of students coming from different Gulf and other Arab countries.

The Bahrain Center for Studies and Research (BCSR)<sup>1</sup> - Within its Economic and Social Research Department, 2 scientists (1 national and 1 expatriate) are directly engaged in AR (in rural socioeconomics). It is worth mentioning that BCSR has recently set up (i) geographic information and computer systems departments to provide the latest know-how services with respect to geographic information systems to various government institutions and the private sector, and (ii) a very good documentation service (subscribing to AGRIS).

### **The Other NARS "Technical" Institutions**

The Environmental Affairs (EA) - This planning and regulating agency has two major directorates partially engaged in agricultural development and research. The Environmental Control Directorate (5 national scientists, of whom 2 have PhD degrees) has activities on pollution control, chemical analysis and waste management. The Environmental Assessment and Planning Directorate (7 nationals, of whom 2 have PhD degrees) is involved in the assessment of development projects and their impact, monitoring of the environment, and information management. The 12 graduate staff members represent around 3 pRys.

Al-Areen Wildlife Park (AWP) - AWP is responsible for conservation of the flora and wildlife of Bahrain. It has 7 graduate staff members (6 nationals), partly involved in research activities (equivalent to 2 pRys) conducted in the park (8 km<sup>2</sup>) and in other regions.

## **3 AR RESOURCES (see Table 1)**

### **3.1 Human Resources**

The Bahraini NARS currently (1997) involves around 52 graduate staff members (34 nationals and 18 expatriates coming mainly from developing countries), who represent around 32 pRys (20 of which are provided by nationals).

The academic level of the present national research staff is low, especially at ARD. Despite recent improvements in their status, the national scientists at the AR institutes (ARD, FD) are considered government officials, and their salaries are well below those of university professors and senior staff in large state companies, which explains the difficulties the AR institutes have in attracting, motivating, keeping and training researchers.

As far as support personnel are concerned, the AR institutes appear to pay little attention to technicians, who tend to be insufficiently qualified and too few (almost one per researcher), whereas the number of unskilled permanent workers appears to be reasonable (close to 4 per researcher).

### **3.2 Physical and Financial Resources**

Due to the declining state revenues, all government expenditures had to be curtailed and AR was significantly affected. This meant a halt in recruitment, a cutback in equipment, physical and operational expenditures, etc. The remaining resources have to be concentrated on high-priority issues.

Physical resources at the AR institutes are still acceptable in most of the NARS institutions, except at FD where they are modest. Buildings have been relatively improved since 1996, but at the AR institutes most of the scientific and other equipment (including vehicles, photocopiers, documentation services, etc.) need to be renovated or reinforced.

In 1996, the total NARS financial resources amounted to around BD 1.2 million (US\$ 3.2 million), coming from allocations from the national budget, without any external contributions (grants or loans). These resources represent about 6.4% of the Agricultural Gross Domestic Product (AGDP, estimated at around US\$ 50 million in 1996). Such a high ratio, the highest in the WANA region, is inherent to the small size of the national agricultural sector, it amounts to around 0.9% of the total value of the AGDP and food imports.

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<sup>1</sup> BCSR is a semiautonomous organization overseen by a Board of Trustees chaired by the Crown Prince. It has 19 graduate staff members, all PhD holders (18 national, 1 expatriate) who conduct research in two departments: the Scientific Research Department and the Economic and Social Research Department. It supports research implemented by other national scientific institutions, mainly in economics (it has supported agricultural and fisheries research topics during the last decade). It provides finance, literature, liaison and guidance, and organizes various economic and scientific conferences and symposia.

OCC per pRY is still relatively sufficient at ARD (around US\$ 30,000), but insufficient at FD (US\$ 13,500)<sup>1</sup> compared with the "optimal" amount of US\$ 25,000–30,000 per RY used in the long-term plans designed by many developing countries. According to this last reference and supposing that the OCCs per RY in the other NARSs are in an intermediate position between ARD and FD, the Bahraini NARS would have roughly around 24 actual RYs, instead of the 32 pRYs estimated above.

## 4. RESEARCH ACTIVITIES

### 4.1 Research Activities and Relations with Development

Research efforts on protected crops/vegetables, data palm, animal production, and fisheries do not match the current and prospective importance of these commodities in the AGDP. In the future, these research programs should be better balanced, and research on natural resources and rural socioeconomics should be reinforced.

The NARS profits from various scientific results, borrowing broadly from innovations made in other countries of the region. In general, relations with development have been effective with respect to the major vegetables. For other commodities, links between research and extension have been much less effective, and the financial limitations of the NARS institutions make it difficult to transfer technological improvements to farmers. However, demonstration trials (research liaison services) on farmers' fields, set up and developed since 1990, have been useful for the extension tasks as well as for providing feedback on the needs of AR users.

### 4.2 International Linkages

While international cooperation was previously very limited, it has now considerably extended towards other sources of bilateral assistance (USA, Japan, Taiwan), international AR centers (mainly ICARDA and ICRISAT) and agencies (AOAD, FAO).

## 5. CONCLUSION

The Bahraini NARS is still modest and inherently expensive due to the small size of the agriculture sector. Although considerable progress has been made recently with regard to its structure and general administration, there is still a great deal to be done with regard to human, material and financial resources and the imbalances between them as well as training and preparation of the medium- and long-term National Research Strategy Plan.

Its consolidation should be tenaciously pursued particularly with a view to: (i) improving the qualifications and salaries of the AR institutes' senior staff and technicians, bringing its research programs into better balance; and (ii) renovating infrastructures and equipment and promoting international relations, especially with neighboring countries.

### Main Acronyms

**MVA:** Ministry of Works and Agriculture. **MCAI:** Ministry of Cabinet Affairs and Information. **MHME:** Ministry of Housing, Municipalities and Environment.

**ARD:** Agricultural Research Directorate. **AWP:** Al-Areen Wildlife Park. **BCSR:** Bahrain Center for Studies and Research. **DAZ:** Program for Desert and Arid Zones Sciences. **DB/CS:** Department of Biology, College of Science (Bahrain University). **EA:** Environmental Affairs. **FD:** Fisheries Directorate.

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<sup>1</sup> Estimates taking into account that: (i) the numbers of pRYs are lower than the numbers of graduate staff members, and (ii) part of the OCC is allocated to other activities that are generally less expensive than research (see Table 1, note m).

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**Table 1 - The National Agricultural Research System (1996/97)**
*Italics* Approximate data      ... Data not available      \* See footnotes

NARS Institutions				Graduate Scientific & Tech. Staff (Units)				Potential Research Years*			Total Budget* (1000 BD)	AR Expend/ Resources (E)* (1000 BD)	
No.	Name – Acronym Head Office – Year Established	Mandates AR Fields	Govern. Minist.	Nationals Total - (PhD, MS)	Exp.	Total	Nat.	Exp.	Total				
a	B	c	d	e	f	g	h	i	j	k	l	m	
1.1	Ag. Research Directorate Bahrain	ARD 1935-91	AR (75%) - (AD) Crops, animal/forage...	MWA	7	0, 3	8	15	5	8	11	630	570
2.1	Fisheries Directorate Manama	FD 1979	AR (70%) - (AD) Fisheries	MWA	12	2, 3	3	15	8	2	13	370	310
1/2	Total AR Institutions				19	2, 7	11	30	13	8	21	1000	880
4.1	Department of Biology, Coll. of Sciences Bahrain University, ...	DBCS 1985	HE - R - (AR) Plant/animal/marine bio	ME	6	2, 4	3	9	2	1*	3	...	180
4.2	Prog. Desert & Arid Zones Sc., College of Applied Sc.* Arab Gulf University (AGU)	DAZ/CAS 1985	HE - R - (AR) Desert/agriculture	AGU*			2	2		1	1	...	
4.3	Bah. Center for Studies and Research* Awali	BCSR 1981	R - (AR) Rural socioeconomics	*	1	1, 0	1	2	1	1	2	...	
4	Total Other Scientific Institutions				7	3, 4	6	13	3	3	6	...	180
5.1	Environmental Affairs* Manama	EA 1981	AD - (AR) Environment	MHME	12	4, ...		12	3		3	...	150
5.2	Al-Areen Wildlife Park* Al-Zalag	AWP 1976-79	AD - AR Wildlife	MCAI	6	... ..	1	7	2		2	...	
5	Total Other Technical/Admin. Institutions				18	... ..	1	19	5		5	...	150
6	Total NARS				34	... ..	18	52	21	11	32	...	1210
Exchange Rate: 1 Bahraini dinar (BD) = US\$ 2.65, US\$ 1 = 0.378 BD (1996 average rate)				Actual Research Years (aRY) (Estimate) →						24		AR Expendit. (million US\$) →	3.2

MWA: Ministry of Works and Agriculture; ME: Min. of Education; MHME: Min. of Housing, Municipalities and Environment; MCAI: Min. of Cabinet Affairs and Information

c: Mandates AR (%): Approximate average % of resources devoted to ag. research (AR), R: Research, HE: Higher education, AD: Ag. development/services (seed production, soil analysis, studies, etc.)

g: Expatriates come mainly from developing countries and are funded by the national institutions i, j, k: Potential research years (pRYs) equivalent full-time researcher i, m: All financial resources are national, m: For the AR institutions, AR financial resources have been roughly estimated through the following formula: Total budget × [(a + 0.5(100% - a))], a being the % of time devoted to AR by the graduate staff

\*4.2, 4.3, 5.1, 5.2: Data on human and financial resources are related only to AR resources 4.2: DAZ has a total of 8 academic staff members (4 nationals, 4 expatriates), AGU is in six other Arab countries 4.3: BCSR (19 PhD senior staff, of whom 18 nationals, 1 expatriate) is a semi-autonomous organization responsible for coordinating the national scientific policy, overseen by a Board of Trustees chaired by the Crown Prince 5.1: EA has 2 directorates partially engaged in agricultural development and research: the Environmental Control Directorate (5 nationals, of whom 2 are PhD holders) and the Environmental Assessment and Planning Directorate (5 nationals, of whom 2 are PhD holders)

National/Total AR expenditures (NE/TE): 6.4% of the Agricultural Gross Domestic Product (AGDP): around US\$ 50 million in 1996.

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF THE UNITED ARAB EMIRATES <sup>1</sup>

## 1. HISTORICAL BACKGROUND

Agricultural Research (AR) has been ongoing in the United Arab Emirates (UAE) for over five decades. As early as 1940 the British Government initiated an Agricultural Department at Digdaga in Ras Al-Khaimh to serve most of the northern and eastern Emirates.

After 1971 when the UAE union was established, AR expanded rapidly with the strong support of the highest national authorities. In 1972, the Department of Research and Plant Production (DRPD) in the Ministry of Agriculture and Fisheries (MAF) was formed, and in 1975 the Agriculture and Animal Husbandry Department of Abu Dhabi Government established an Agricultural Research Center at Al-Ain. From 1975 to 1985, FAO provided some scientists who introduced the modern irrigation systems. In 1978, the Marine Center at Um Al-Quwain (MCUAQ) was set up with technical assistance from the Japanese International Cooperation Agency (JICA). In 1980–1981, the Faculty of Agricultural Sciences at UAE University was opened.

Among the latest news from the UAE NARS is the completion, in 1999, of the Biosaline Agriculture Center situated in Dubai and funded by the Islamic Bank.

## 2. THE CURRENT NARS

### 2.1 Overview (see Table 1)

The present (1999) public NARS is consists of

- Four institutions affiliated to MAF which have AR as their main mandate: the AR Directorate of the Department of Research and Plant Production (DRPD), the Agricultural Research Center (ARC) of the Agriculture and Animal Husbandry Department, the Artificial Insemination Center in Ajman, and the Marine Center at Um Al-Quwain, presented in Section 2.2; they account together for 77% of the total potential research years (pRYs: equivalent full-time researchers).
- The Faculty of Agricultural Sciences at the UAE University, affiliated to the Ministry of Higher Education and Scientific Research (MHESR) (18% of the pRYs), and presented in Section 2.3.

A few other national institutions may have some staff members qualified in AR-related scientific fields and may allocate some resources to AR, but precise data on this scientific potential is not available, except for the Biology Department (19 academic staff members, all PhD holders, 3 of whom are national and 16 expatriate) of the Faculty of Sciences of UAE University which has a graduate study program in environmental sciences<sup>2</sup>.

A Coordination Committee between MAF and the Ministry of Higher Education, chaired by the Dean of the Faculty of Agricultural Sciences, was set up in 1998 for coordination of AR in the UAE.

Outside the UAE NARS, at the invitation of MAF, ICARDA has opened (in January 1997) in Dubai a regional office for AR in the Arabian Peninsula. This office, which is hosted at the DRPD Dhaid Research Station, has three international scientists, and the UAE has agreed to provide experimental areas for collaborative research with the NARS.

### 2.2 The AR Institutions

#### The AR Directorate (ARD) of the MAF Department of Research and Plant Production (DRPP)

This Directorate is the major component of the NARS (about 46% of the total pRYs). Its main mandate (which mobilizes around 60% of the time of its graduate staff) is applied and on-farm research on palm trees, mango and citrus, indigenous and exotic forages, protected agriculture, water-use efficiency, fertilization, and plant protection. It is responsible for the central laboratories in the country. Other activities cover technology transfer. ARD provides

<sup>1</sup> By H.E. Rashid Mohamed Khalfan Al-Shareqi, Under Secretary, MAF, and Professor Mahmoud A. Al-Afifi, Dean, Faculty of Agricultural Sciences of UAE University.

<sup>2</sup> Very few applied AR activities are also carried out in the private sector (no precise information available on them).

technical expertise and support for extension (on-farm trials and demonstrations, publications, recommendations, consultancies, and training for extension personnel) and services (materials and equipment evaluation and testing).

ARD employs 57 graduate staff members, 22 of whom are national (1 PhD, 3 MS, 18 BS) and 35 expatriate (mainly from Egypt, Syria, Sudan, Jordan, and Palestine), who represent around 34 pRYS<sup>1</sup>. With the recent move towards employing more nationals in administrative positions, the number of nationals is increasing, but industry tends to attract the better graduates as incentives to those employed with MAF are low and motivation could be improved. ARD also has 10 permanent technicians (5 of whom are national), too low a number for facing the research needs, and many other support staff (clerks, laborers, etc.).

ARD physical facilities are well equipped and maintained; they consist mainly of

- Four research stations (150 ha in total) at: Hammaniah (responsible for research on crop production and technology transfer), Dhaid (research on date palms, forages, vegetables, and crop water requirements), Dibba (research on fruits, well-equipped laboratories for tissue culture and controlled environment, poly-houses for virus-free plant production, etc.), and Fujairah (in the eastern side of the country).
- Central Laboratories located at Al-Ain, where most of the analyses (soil, plant, animals, herbicides, insecticides, fertilizers, soil conditioners, etc.) are carried out for research purposes and public services.

The exact ARD annual budget is not available, but inadequate funds are one of the main reasons for slow implementation of research programs.

ARD gets some assistance from local and international companies who provide materials to be tested in the field. These materials (seeds, chemicals, irrigation systems, and agriculture equipment) have to be approved for the UAE through research in MAF before selling in the market.

#### **The Agricultural Research Center (ARC) of the MAF Agriculture and Animal Husbandry Department (AAHD)**

ARC, based at Al-Ain, is part of the Abu Dhabi Municipality. It conducts applied research and extension on plant and animal production for the Abu Dhabi Emirate.

It has 18 graduate staff members (1 PhD, 2 MS, 15 BS), including 2 nationals and 16 expatriates. It enjoys excellent physical facilities (well-equipped laboratory; field facilities at three different locations in Al-Ain, including green houses and nurseries to produce seedlings; etc.). Financial resources are substantial but their exact figure is unknown.

AR activities focus on food and industrial crops, including date palm production and protected agriculture (7 scientists), forage resources (3 scientists), and animal production.

#### **The Artificial Insemination Center (AIC)**

AIC, established in 1985, is now a section of the MAF Animal Health Department (AHD). It has its main center (laboratories and a computer network) at Ajman and 5 branches in Abu Dhabi, Dubai, Al-Dhaid, Khorfakan, and Ras Al-Khaimah. Its main objectives are to conduct research activities on artificial insemination and to convey the findings to animal owners. Major areas of research are herd fertility, herd reproductive health, breed adaptability, and sheep and goat reproductive management.

Its graduate scientific and technical staff includes the national manager (BS holder) and 9 expatriates.

#### **The Biosaline Agriculture Center (BAC)**

This Center is a new agriculture applied research institution specializing in the utilization of saline, brackish, and sea waters for agriculture and revegetation and is being developed at 23 km from Dubai. It is financed by the Islamic Development Bank (IDB) in cooperation with MAF and UAE University. The new institution, which should be open by mid-1999, will become a center of excellence in its field, primarily serving the Gulf region but with an international focus.

#### **The Marine Center at Um Al-Quwain (MCUAQ)**

MCUAQ is ideally located on the western side of the entrance of Um Al-Quwain lagoon (in the Um Al-Quwain Emirate) where its research and development infrastructure (laboratory, seed production unit, fish feed production unit, aquarium, library, workshop) is located.

Its objectives are to (i) conduct biological and hydrographical research and surveys; (ii) produce seeds for commercially important fishes and shrimps by artificial methods and grow them to a marketable size; and (iii) adapt these new techniques and train the local staff and fishermen on how to use them. Also, through cooperation with

<sup>1</sup> Number of pRYS = Number of graduate staff members × 60% (percentage of the graduate staff's time devoted to AR).

similar regional and international centers, it conducts research out of its base on cage culture of fish, mangrove afforestation, field surveys in pollution-affected areas, and culturing of freshwater fish (*Tilapia*) in farmers' irrigation reservoir tanks.

MCUAQ currently has 9 graduate staff members: 5 nationals and 4 expatriates.

### **2.3 The Faculty of Agricultural Sciences (FAS) of the United Arab Emirates University, Al-Ain**

FAS academic staff members are engaged mainly in education. FAS offers BS degree courses as well as special training courses for the employees of different agriculture departments in the country. It consists of three departments: Plant Production, Animal Production, and Foods and Nutrition, which are engaged in education and academic research. FAS now has a joint MS program which is administered by the Dean of the Graduate Office, and FAS is involved in two of its programs: Environmental Science and Water resources.

FAS has 53 academic staff members of whom 16 are national (5 PhD, 6 MS, 5 BS) and 37 expatriate (mainly from Egypt), supported by 9 technicians (2 of whom are national). Physical facilities for education as well as for research are excellent (properly equipped laboratories; library among the best in the region; generalized access to Internet; excellent farm of 40 ha, including 5 ha for field trials; etc.). Data on financial resources are not available.

Academic staff members allocate about 25% of their time to research activities (they represent 13 pRys) in the domains of irrigated crops (palm, horticulture, forage, soil, water, etc.), livestock, fisheries, and food technology. Most of the work is connected with thesis preparation for BS-level programs. FAS publishes a journal titled *Emirates Journal of Agricultural Sciences* every six months.

## **3. AR RESOURCES**

### **3.1 Human Resources**

The UAE NARS currently (1997) involves 166 scientific and technical senior graduate staff members (including 49 nationals and 117 expatriates), who represent roughly 73 pRys.

Among the national graduate staff members, 10 have a PhD (20%) and 13 an MS (26%) degree. The level of academic training is higher at UAE University (42% with PhD holders at FAS and the Biology Department); this discrepancy could be explained by the difference in salary scales between the MAF institutions (where salaries are similar to those paid for all national civil service employees) and the University (salaries are much higher). However, MAF is giving great attention to developing national scientists in quality and number. Recently, a Civil Servants Law was set up which proposes giving better financial incentives to agricultural scientists with higher degrees.

In general, the number and quality of technicians and other support staff (laborers, clerks) are insufficient due to the very low salaries offered by the public institutions. Most of the technicians are expatriates and many of the laborers are illiterate with little interest in the research programs. This situation is a strong limiting factor to the scientists' research efficiency and the amount of quality research that can be achieved.

### **3.2 Physical and Financial Resources**

The network of NARS locations (labs, farms, etc.) is rather well distributed all over the country in the seven Emirates, and covers all agroclimatic zones and different fields of research. In general, the working resources at the NARS institutions are in good condition.

The total AR expenditure is not known. As seen above, DRPD financial resources are limited while most of the other institutions are enjoying much better conditions.

## **4. RESEARCH ACTIVITIES**

### **4.1 Research Lines**

Research programs are mainly applied<sup>1</sup> and concentrated on irrigated farming systems, including the palm system (palm and agriculture under palm: vegetables, cereals, forages, small ruminants, etc., which cover 60% of the cultivated lands), the greenhouse system, and all themes related with these systems and with soil and water

<sup>1</sup> With advanced techniques in some fields, such as tissue culture used in palm research by FAS.

management (irrigation methods and on farm water management, water requirements, salinity, drought resistance, fertility, disease and insect control, etc.). Significant impact on agricultural development is reported, especially in palm production and protection, irrigation scheduling, fertigation, animal production systems, etc. Other programs concern livestock, fisheries, marine ecology, conservation of indigenous forages, and food technology. Little research in rural economics has been conducted but some research on indigenous technical knowledge was initiated in 1998.

Recently, in collaboration with UAE University, the municipalities, and ICARDA, the UAE has been engaged in a very active program on the conservation and utilization of indigenous desert forages, and their evaluation and role in alternative forage systems for goats, sheep and camels. Collection missions have been carried out in the northern Emirates and the germplasm has been stored "in trust" in the Genetic Resources Unit at ICARDA. A small herbarium, flora and gene bank for these important forages was also developed in 1999 at MAF.

To date, there is no precise inventory of the research programs developed by all the NARS institutions. However, this should be done within the scheduled preparation of a national strategy for AR and technology transfer.

#### 4.2 Linkages and Collaboration

Linkages between the NARS institutions have been rather weak until recently, which resulted in duplication of research programs (palms, forages, etc.) and lack of synergy in their implementation. Few collaborative research programs existed until recently; these are now being developed and are encouraged by all institutions. Recently, collaboration between the NARS institutions has been strongly encouraged by MAF, and joint research projects involving MAF, UAE University and the Municipality in Sharjah Emirate have been set up with ICARDA.

Relationships with development agencies, extension services, and farmers take various forms: annual meetings of the technical committees of regional AR centers, seminars, training, and extension programs. They are much better established for ARC than for FAS. ARD and ARC maintain a good relation with most of the agricultural companies: they test seeds, fertilizers, chemicals, irrigation equipment, and other new technologies before introduction into the country.

International cooperation is active with ICARDA, the Arab Organization for Agricultural Development (AOAD), the Islamic Bank for Development, FAO, and many other organizations. Cooperation is in the form of donations and/or strengthening of human resources to make research programs sustainable. FAS has a joint research program with all colleges of agricultural sciences in the Gulf countries.

#### 5. CONCLUSION

The UAE NARS is very young. Within less than three decades it has made considerable progress with regard to its structure, and human, physical and financial resources, and has been serving the agricultural sector well. There is still much to be done, particularly for improving national qualified human resources (researchers and technicians) in the MAF institutions, the relations among these institutions and FAS, and international scientific linkages. The AR Coordination Committees and the Amended Joint Agricultural Policy for the Arab States of the Gulf Cooperation Council will be helpful in achieving this.

#### Main Acronyms

**MAF:** Ministry of Agriculture and Fisheries. **MHESR:** Ministry of Higher Education and Scientific Research.

**ARC:** Agricultural Research Center (MAF Agriculture and Animal Husbandry Department, Al-Ain). **DRPD:** MAF Department of Research and Plant Production. **FAS:** Faculty of Agricultural Sciences, United Arab Emirates University. **MCUAQ:** Marine Center at Um Al-Quwain.

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**Table 1 - The National Agricultural Research System (1997/98)**
*Values: Approximate data ... Data not available \* See footnotes*

NARS Institutions				Graduate Scientific & Tech. Staff (Units)				Potential Research-Years *			Total Budget (Dh 1000)*	AR Budget (Dh 1000)*
No.	Name -Acronym Head Office – Year Established	Mandates AR Fields	Govern. Minist.	Nationals Total - (PhD, MS)		Exp.	Total	Nat.	Exp.	Total		
a	b	c	d	e	f	g	h	i	j	k	l	m
1.1	AR Directorate, Dept of Research & Plant Production ARD/DPRD Dubai	AR (60%) - (AD) Crop, forage	MAF	22	1, 3	35	57	13	21	34	...	...
1.2	AR Center, Agric. & Animal Husbandry Dept Al-Ain, Abu Dhabi	AR (60%) - (AD) Crop, forage, animal	MAF	2	0, 1	16	18	1	10	11	...	...
2.1	Artificial Insemination Center, Animal Health Dept Ajman	AIC/AHD AR (60%) - (AD) Animal breeding	MAF	1	0, 0	9	10	1	5	6	...	...
2.2	Biosaline Agricultural Center* Dubai	BAC AR Biosaline Agriculture	MAF/MHESR									
2.3	Marine Center Um Al-Quwain	MCLUAQ AR (50%) - AD - R	MAF	5	1, 3	9	9	3	2	5	...	...
1.2	Total AR Institutions			30	2, 7	64	94	18	38	56		
3.1	Fac. of Agriculture Sciences, UAE University Al-Ain, Abu Dhabi	FAS 1980	AHE - (AR: 25%) All	MHESR	16	5, 6	37	53	4	9	13	
3	Total Agricultural Sciences Faculties			16	5, 6	37	53	4	9	13		
4.1	Biology Department , Fac. of Sciences, UAE University Al-Ain, Abu Dhabi	FS 1980	HE - (AR :20%) Biol. Environment	MHESR	3	3, 0	16	19	1	3	4	...
4	Total Other Institutions			3	3, 0	16	19	1	3	4	...	...
5	Total NARS			49	10, 13	117	166	23	50	73		

MAF: Ministry of Agriculture and Fisheries; MHESR: Ministry of Higher Education and Scientific Research.

c: Mandates: AR (%): Approximate average % of resources devoted to ag. research (AR); R: Research; AHE: Ag. higher education; AD: Ag. development/services (seed production, soil analysis, extension studies, etc.); i, j, k: Potential research year (pRY) = equivalent full-time researcher; l, m: Data on financial resources (all funded by the UAE) are not available; 2.2: the Biosaline Agricultural Center should be opened by mid-1999

# THE NATIONAL AGRICULTURAL RESEARCH SYSTEM OF YEMEN<sup>1</sup>

## 1. HISTORICAL BACKGROUND

Agricultural research (AR) activities in Yemen date back to the forties when the British Colonial Government (which ruled South Yemen until 1967) introduced the "Lambert type" of cotton from Sudan in the Abyan coastal area. El-Kod Research Station was established in 1955 in this region (50 km from Aden), and research activities were expanded to other field crops. Seiyun Research Center was established in Wadi Hadramout in 1972 to cover the mid-altitude region of South Yemen.

Research activities were later developed in most parts of the country, especially through numerous projects supported by UNDP/FAO and IDA. They were introduced in North Yemen starting in 1970, later developing into a central AR station in Taiz in 1978. In 1980, the Ministry of Agriculture and Agrarian Reform of South Yemen created the Department of Research and Extension (DRE), based at Aden, which was transformed in 1986 to the Directorate of Research and Extension. This Directorate was responsible for research and executed only technical control of extension units. At the same time, the Agricultural Research Authority (ARA) was established in Dhamar in North Yemen for conducting research and applied studies to improve agricultural production.

In 1990, after the unification of North and South Yemen, the Agricultural Research and Extension Authority (AREA) was formed by merging DRE and ARA and their respective research centers and stations. The Extension Department of the General Directorate of Extension and Training (GDET) was transferred to AREA in 1990 and was mandated with the tasks of technical backstopping and strengthening linkages between research and extension. Extension systems, however, are still under different authorities within the Ministry of Agriculture.

Agricultural higher education (AHE), with some related AR activities, started with the foundation of an agriculture institute at Aden in 1975, which became in 1978 the Faculty of Agriculture of Aden University. In 1984, the Faculty of Agriculture of Sana'a University was opened. The Faculty of Agriculture of the University of Ibb and the Faculty of Agriculture and Veterinary Science of the University of Dhamar were established in 1996.

Research on fisheries started with the inception of the Marine Sciences and Resources Research Center at Aden in 1986.

## 2. THE CURRENT NARS<sup>2</sup>

### 2.1 Overview

The NARS of Yemen is currently made up of three main sets of institutions:

- The scientific institutions which have AR as their central mandate: the Agricultural Research and Extension Authority (AREA), affiliated with the Ministry of Agriculture and Irrigation (MAI), and the Marine Sciences and Resources Research Center (MSRC), affiliated with the Ministry of Fisheries, which account together for 76% of the total potential research years (pRYs: equivalent full-time researchers) and 70% of the total financial resources of all the NARS; these two institutions are presented in Section 2.2.
- The four faculties of agricultural sciences, which are more or less involved in AR, account for 16% of the pRYs and 4% of the total financial resources of the NARS (see Section 2.3).
- Other institutions partly involved in AR activities, mainly temporary agricultural development projects (around 8% of the pRYs and 26% of the total financial resources of the NARS) (see Section 2.4).

Limited private-sector research is carried out in collaboration with the public sector, e.g., research on the introduction of hybrid seeds, pesticides, agricultural machinery, and fertilizers.

Since its reorganization in 1996, AREA has been mandated with the supervision and coordination of national AR activities, technical supervision of extension activities, and evaluation and certification of research results in the country. In fact, this mandate overlaps with some activities within MAI, and AREA has actually some difficulty in insuring its

<sup>1</sup> By **Dr I. Muharram**, Chairman, AREA; **Dr Saleha Nahdi**, Professor, FAUS; and **Dr A.M. Bamatraf**, Vice Minister, MAI, with the support of **Dr. S.V.R. Shetty**, Team Leader, ICARDA-Yemen.

<sup>2</sup> Unless otherwise indicated, most of the data in this monograph relate to 1996.

role. However, a National AR and Extension Council and an AR Scientific Technical Working Committee set up by AREA in 1991 and 1995, respectively, are still supposed to determine the national AR policy and coordinate the NARS institutions.

## 2.2 The Agricultural Research and Extension Authority (AREA)

### Mandate and Organization

AREA is by far the largest NARS institution with 67% of the pRY and 68% of the financial resources of the NARS. It is a semi-autonomous institution governed by a Board of Directors, with the membership of representatives from various ministries<sup>1</sup>. The Chairman of the Board, who is the principal executive of the Authority, is assisted by a Vice Chairman for Research and Extension and one for Finance and Administration, and a Director General of Research and Extension. Together, they ensure the overall planning and management of the research and extension programs and their full coordination.

AREA carries out applied and adaptive activities in all fields; these activities mobilize around 60% of the time of the senior staff. Its other activities cover extension (technical expertise and backstopping of extension institutions or projects, technical support and publications, recommendations, training for extension personnel, on-farm trials and demonstrations, etc.), services (soil analysis, seed production), and consultancies.

### Human, Physical and Financial Resources

AREA currently has 274 scientific and technical graduate staff members, including 255 nationals<sup>2</sup> and 19 expatriates, who represent around 164 pRYs<sup>3</sup>. The rather low qualifications of the graduate national staff (45 PhD, 68 MS, 142 BS) can be explained by the past loss of many trained researchers to the universities because of the better salaries observed there until 1996 when the salaries of AREA staff increased to be equivalent to those of academic staff<sup>4</sup>. The distribution of researchers with respect to the different regions based on the needs of the regions is unbalanced: for example, 32.5% of AREA research staff and about two-thirds of the PhD and MS holders are located in El-Kod and Seiyun Research Stations, and only 2% in the Eastern Region (Marib).

AREA employs also 242 junior technicians and other support staff (clerks, accountants, laborers, etc.). The ratio of technicians and other support staff to graduate staff member (1 and 2, respectively) is half the general agreed upon standard (2 and 3–4).

Besides the headquarters located in Dhamar, AREA has five specialized centers: the Livestock Center in Lahaj, the National Resources Management Center, the Food and Post-Harvesting Technology Center, the National Agricultural Training Center (all three in Dhamar), and the Mass Media Center in Sana'a. Eight regional stations cover research in field and horticultural crops, plant protection, soil and water, farming systems, livestock, and forestry in the different agroecological zones.

The area of all these units sums up to around 392 ha. In general, research facilities (offices, labs, farms, equipment, vehicles, etc.) and information services are poor and need repair and spare parts. There is a need for computers for conducting statistical analysis and data processing. A database center has recently been established in Dhamar, but lacks skilled staff and appropriate facilities. The central library has poor stocks of journals.

In 1997, the total AREA financial resources amounted to around Yemeni riyals (YR) 755 million (US\$ 6 million), of which:

- YR 180 million came from national sources, mainly through local recurrent budget and, to a limited extent, through income generated from production;
- YR 125 million (US\$ 1 million) (from a World Bank loan) received through the research component of the Agricultural Sector Management Support Project (ASMSP) since 1995;
- YR 450 million (US\$ 2.9 million) from foreign grants, the major donors being the Netherlands and Germany.

<sup>1</sup> AREA's legal status was defined by a presidential decree in 1998.

<sup>2</sup> In 1989, AREA had 207 professional graduate staff, consisting of 173 nationals (23 PhD, 67 MS, 83 BS) and 34 expatriates. In 1992, this national staff was 235 (27 PhD, 82 MS, 126 BS) (Source: Hariri, 1994).

<sup>3</sup> pRYs = Number of researchers on duty x 60% (percentage of the senior staff's time devoted to AR).

<sup>4</sup> The current average monthly salaries of AR and academic staff is YR 48,000 (US\$ 380), 31,000 (US\$ 250) and 28,000 (US\$ 220) for PhD, MS and BS holders, respectively, and YR 12,000 and 8,000 for technicians and laborers.



Since 1980, the national resources have remained stable or slightly decreasing in US\$ equivalent (2 million in 1980, 5 million in 1987, 1.7 million in 1996). But with the increase of staff number, the part allocated to salaries has been growing over the years, reaching 91% of the national budget in 1995 and 1996 and 92% in 1997. Now, the operational and capital costs (OCC) are mainly funded by the loan and the foreign grants. Assuming that two-thirds of these external funds are allocated to the expatriates' salaries and to OCC, the total OCC may amount to around US\$ 9,500 per graduate staff member, which is very insufficient for providing satisfactory conditions of work (see Section 3.3).

Financial management of AREA headquarters is weak and audit accounts are delayed.

### Research Activities and Linkages

Research planning is done according to the five-year plan and annual planning exercises (see Section 4.1). However shortages of researchers and financial resources are crippling the implementation of the planned activities.

Currently, 32% of the AR senior staff are allocated to field crops; 10% to horticulture, forestry and animal production; 15% to natural resources; 2% to food technology; and the numbers of socioeconomists are almost negligible. Only the research programs/activities which benefit from external financial support are actually implemented, mainly resource characterization (with FAO), networking on crops, and farming systems and on-farm trials (with ASMSP). Except in these externally supported programs, research outputs are inadequate due to financial difficulties and the lack of resources, incentives and accommodation facilities in remote rural areas.

The current organization of research activities is poorly defined, with some sections and units existing only on paper. Lines of authority and communication are not clear.

Cooperative relations exist with international organizations and international agricultural research centers (IARCs) such as ICARDA, CIMMYT, ICRISAT, IBPGR and ACSAD, mainly in exchange of genetic resources and information, and training of AREA staff. Yemen receives both technical and financial support from different donors, e.g., Germany, the Netherlands, the UK, the World Bank, UNDP, ICARDA and FAO.

AREA is a member of some research networks and projects like the Sorghum and Millet Network with Asian countries (coordinated by ICRISAT), Oil Seed Crops Development Network with Somalia and Sudan, Irrigation and Water Management Network with several Arab countries; the ICARDA Nile Valley and Red Sea Regional Program (with Egypt, Eritrea, Ethiopia and Sudan) and the Arabian Peninsula Regional Program (with the Gulf countries and Saudi Arabia).

Through these activities, AREA benefited by providing on-the-job training for its permanent staff, obtaining equipment, exchanging information, joint planning and implementation of research activities.

### **The Marine Sciences and Resources Research Center (MSRC)**

MSRC is a semi-autonomous institute within the Ministry of Fisheries. It carries out applied and adaptive research activities on fisheries and oceanography, which mobilize around 50% of the time of its senior staff (other activities cover survey of national fisheries resources, extension).

MSRC has 46 graduate staff members, all nationals (5 PhD, 25 MS, 16 BS). Apart from the headquarters located in Aden, MSRC has two branches: one in Hodeida and another in Mukhala.

Its total financial resources amount to around YR 23 million (\$US 0.18 million), mainly from national sources, i.e., about US\$ 3,900 per graduate staff members. OCC is extremely low; accordingly, no significant research program is under way, and the graduate staff is currently largely underemployed.

MSRC has poor external relations, limited to the membership of an international aquaculture network funded by the Netherlands and UNDP.

## **2.3 The Four Faculties of Agricultural Sciences**

**Overview** - These are:

- The Faculty of Agriculture of Sana'a University (FAUS), with 77 academic staff (all nationals: 45 PhD, 8 MS, 24 BS), supported by 11 technicians and other support staff (clerks, laborers);
- The Faculty of Agriculture of Aden University (FAUA), with 72 academic staff (including 60 nationals: 42 PhD, 15 MS, 3 BS; and 12 expatriates, all PhD holders);

- The Faculty of Agriculture of the University of Ibb (FAUI) and the Faculty of Agriculture and Veterinary Science of the University of Dhamar (FAVUD), both established in 1996, which do not have permanent academic staff (education provided by scientific staff coming from FAUA and FAUS).

The four FASs are semi-autonomous, public institutions within their respective universities, affiliated to the Ministry of Education (MOE). They provide BS degree education. FAUS and FAUA have started recently a postgraduate program.

The 149 academic staff members of the FASs represent 38 potential RYs<sup>1</sup>. Physical resources are limited, except at FAUS which has good laboratory facilities (infrastructure and equipment renovated in 1993/94 through the assistance of USAID and the Islamic Bank).

The total national budget of the four FASs amounts to around YR 60 million (US\$ 0.48 million), of which 30 and 15 are for FAUA and FAUS, respectively, which means about US\$ 3,200 per academic staff member for all the academic and research activities and all costs (salaries and OCC). External resources are mainly allocated to the cost of the expatriates; they may roughly amount to US\$ 1 million (YR 120 million), but such amount may not exceed US\$ 250,000 (about YR 30 million) at the "national cost" (when estimating the salary costs of the expatriates on the basis of the average salary cost of national graduate staff).

**Research Activities** - The availability of highly qualified staff and of students who could be associated with research offers a large comparative advantage for the FASs to implement AR programs; however, AR is constrained by several factors:

- Academic staff members have little time available for research because of the excessive teaching loads dictated by the large numbers of students.
- Research resources are rather limited: technicians are scarce and mainly mobilized by the education activities, physical resources are limited, and financial resources are meager and spent mostly on salaries; there are no funds for research.
- The links with AREA, development/extension organizations and external educational and/or research institutions are very limited.

So far, AR activities have been very modest at FAUS and FAUA and have not yet been developed at FAUI and FAVUD. As a consequence, the time allocated for research by the academic staff members does not actually exceed 10%, which gives less than 15 actual RYs for the four FASs.

## 2.4 The Other NARS Institutions

### The Other Scientific Institutions

Apart from the FASs, the Yemeni universities have some faculties (sciences, economics, etc.) with units/departments specialized in agriculture-related sciences, such as those of plant/animal biology, food technology, rural geography, socioeconomics, etc. A recent, complete inventory of these units is not available; it is even difficult to have a rough estimate of the total number of scientists concerned.

### The Development Projects Involved in AR Activities

Numerous agricultural/rural development projects funded by bilateral and multilateral agencies have an AR component, some with a proper research-development unit. Since an up-dated precise inventory of these units is not available<sup>2</sup>, it is difficult to have a precise idea of the AR activities and resources of these projects.

However, it is worth mentioning that in 1997, 11 development projects funded by the World Bank, UNDP, Germany, and IFAD represented an external amount of US\$ 142 million (including US\$ 135 million as loans and 7 as grants<sup>3</sup> for

<sup>1</sup> Taking into account the normative rate of 25% of the academic staff members' time allocated to AR activities, adopted for the analysis of all the WANA NARS (see methodology of the study).

<sup>2</sup> Recently, it was decided to make an inventory of research activities within the projects for developing the National Agricultural Research Program (NARP). This will be ready in September 1999.

<sup>3</sup> Among the eight projects funded by the World Bank (total loan around US\$ 115 million) there were 6 regional projects (Tihama/coastal region; southern and northern mountain regions; eastern region; Wadi Hadramout/eastern desert, south) focusing on natural-resource management, and 2 national projects (land and water conservation; seeds and agricultural services). The two national projects funded by UNDP and Germany (US\$ 7.5 million as grants) were the Sustainable Water Resources Management Project and the Sustainable Environment Project, implemented by the National Water Resources Authority and the Environmental Protection Council, respectively. IFAD supported the Tihama Environmental Protection Project through a loan of US\$ 20 million.

the time of their duration (between 3 and 8 years, with an average of five years), with 5 to 10% of their total funding allocated to AR (very rough estimate through a quick survey). This would mean that at least about US\$ 1.5 million per year (YR 190 million) were allocated to AR activities in these projects (mostly funded by loans), carried out by proper research units and staff (at least 10 expatriates and their national counterparts), often in collaboration with AREA<sup>1</sup>.

It also seems that AR activities in development projects concern mostly regions and scientific fields (mainly natural resources) poorly covered by AREA and the FASs.

### 3. AR RESOURCES

#### 3.1 Human Resources (see Table 1)

In 1997, the Yemeni NARS involved less than 500 scientific and technical senior graduate staff, who account for about 245 potential RYs (220 national, 25 foreign), most of this staff being from AREA and the FASs.

The level of academic training is quite good at the FASs (63 and 17% PhD and MS holders, respectively) but insufficient at AREA (only 18% with a PhD degree). The recent improvement of the status and salaries of AREA researchers opens possibilities for better equilibrium in the future. Staff of these agricultural scientific institutions remains highly concentrated in a few places; some agroecological regions (eastern region) are far from being covered according to their agricultural importance.

In general, the number and quality of technicians and other support staff (laborers, clerks) are insufficient due to the very low salaries offered by the public institutions. This situation is strongly affecting the scientists' research efficiency.

#### 3.2 Physical Resources

The most important physical research resources of the NARS are within AREA units (headquarters, centers, stations), which are rather well distributed in the country. Most of the FASs have very modest research facilities, with the exception of FAUS.

Until recently, land was sufficient; however, large areas have now been taken by the Government. The other physical resources (offices, farm buildings; laboratories; libraries/documentation services; scientific, computer, transport and communication equipment) are inadequate and/or need efforts for maintenance and/or modernization. The common problem at present in all institutions is the absence of a central workshop for maintenance of equipment. Often costly equipment remains unused because the staff does not know how to operate it or because of some minor problem such as replacing the spare parts.

#### 3.3 Financial Resources (see Table 1)

In 1997, the total (national and external) AR financial resources amounted to around YR 760 million (US\$ 61 million), of which YR 180 million (US\$ 1.4 million) came from national sources (mainly the government budget), YR 260 million from loans (from the World Bank to AREA and from diverse donors to AR activities within the development projects), and YR 320 million (US\$ 2.6 million) from external grants secured through bilateral or multilateral donors. This breakdown clearly shows that the NARS relies mainly on external funds, especially for OCC.

The AR total resources of the NARS amount to around 0.68% of the Agricultural Gross Domestic Product (AGDP estimated at US\$ 0.9 billion in 1996). The national contribution represents only 0.16% of the AGDP, but reaches 0.39% when adding the loan which will be finally paid by the country. Such ratios are much under the 1% recommended ratio by some international organizations (World Bank, European Union, etc.). This statement pledges for an increase of the national financial resources to take into account the needs of the national scientists, and to keep an acceptable balance with external funds, especially with the loans.

Areas of expenditure vary between the NARS institutions; however, in the scientific institutions, the available OCC per graduate staff member is relatively low and inadequate for allowing satisfactory work conditions. The corresponding OCC

<sup>1</sup> These conservative estimates do not take into account other projects that may also be involved in AR and funded by other donors, such as the Environmental Resources Assessment for Rural Land Use Project (FAO and the Netherlands), the Innovation Development in the Agricultural Sector Project (GTZ), the Mountain Terrace Project (IDRC), the Nile Valley and Red Sea Regional Program, coordinated by ICARDA, etc.

per pRY (around US\$ 13,000<sup>1</sup> at AREA, less than US\$ 3,000 at MSRC and the FASs) is much under the "optimal" amount of US\$ 25,000–30,000 per RY used in the long-term plans designed by many developing countries, which means that the AR scientific potential is currently far from being fully mobilized. According to this reference, the actual scientific potential of the NARS amounts to approximately 105 actual RYs (of which around 65 are at AREA, 5 at MSRC, 15 at the FASs, and 20 in the development projects) as opposed to the 245 pRYs estimated above, which means that the human potential of the NARS is much underemployed.

## 4. RESEARCH ACTIVITIES

### 4.1 Research Orientation

Research planning is officially done according to the agricultural component of the national development plans. For instance, the 1996–2000 development plan emphasizes a number of areas such as:

- Adopting the farming systems approach to research and extension, in particular to rainfed agriculture. At present, research is commodity oriented.
- Natural resource management research to conserve the overexploited water resources, and to prevent land deterioration due to soil erosion, terrace deterioration, and degradation of crop cover leading to desertification, as well as to conserve genetic resources.
- Integrated pest management and biological control of virus and virus-like diseases of citrus, dates, sub-tropical fruits, vegetables, cereals and industrial crops; control of pests, vectors and pathogens; improving lines through breeding for resistance; control of losses at the field and post harvest levels; and forecasting epidemic outbreaks.
- Crop improvement for wide adaptability and tolerance to stresses (drought, salinity and pests), introduction of high-yielding varieties, improvement of cultural practices, encouraging breeding for multiple resistance using traditional plant breeding and new biotechnology approaches.
- Rangeland and livestock production, especially sheep and goats, and control of rangeland degradation by introduction of rangeland practices and production of green forage.

Until 1997, AREA was not able to follow this orientation; its resource allocation is still rather unbalanced between research fields and regions, and this weakness is partly compensated for by the temporary projects/programs.

The national AR strategy recently prepared with the assistance of ICARDA and ISNAR will help in strengthening priority scientific and regional areas and the development of medium- and long-term plans according to a time schedule.

### 4.2 National and International Linkages

Relations of AREA with development and extension organizations suffer from the poor distribution of its researchers and its focus on commodity-oriented research; however, the process of research decentralization and the higher attention given to farming-systems-oriented research are promising for the future. In general, the FASs are not serving agricultural development, and AR activities in the development projects are suitably related with farmers' issues.

In spite of the many constraints and weaknesses, AR activities seem to have met some of the development objectives of the country; for example, self-sufficiency in vegetables and fruits has been achieved.

At the national level, linkages (which remain very weak at present) between AREA and each of MAI, Ministry of Planning and Development (MPD), Ministry of Finance (MOF), Ministry of Education (MOE), and the universities are mainly through its Board of Directors, where representatives from these organization are members. Linkages with the universities are weak and are at the individual level, even though the deans of FAUA and FAUS are members of AREA Board of Directors. There is no representative from AREA at the faculty councils.

As seen above, international scientific linkages are relatively important for AREA, and have been highly profitable (joint planning and implementation of research activities, on-the-job and foreign academic training for its permanent staff, exchange of information, procurement of equipment, etc.). These linkages are rather poor for MSRC and the FASs.

<sup>1</sup> As the numbers of pRYs are lower than those of graduate staff members, but part of the OCCs are allocated to other activities than research (see Table 1, note related to AREA).

## 5. CONCLUSION

The Yemeni NARS is young. Its permanent scientific institutions have been established recently and have grown quickly. Although there has been an annual increase in their staff numbers, funds have not increased accordingly and national resources per scientist have become more and more limited.

AREA is the unique AR institution officially responsible for all AR activities in the country (except the fisheries research sector for which MSRC is responsible). However, it currently has limited relations with the two other main components of the NARS (FASs, development projects). Coordination and communication within the NARS are weak at all levels, and it has been difficult so far to take advantage of the comparative advantages of its institutions: large number of human resources and important physical resources at AREA; highly qualified and stable staff at the FASs; and good funding and external relations in the projects.

Through the implementation of the medium-term plan, AREA should improve its efficiency (higher qualification and stability of its researchers; better balance among the research fields and regions; larger number of technicians; higher national funds; etc.) and be able to progressively meet the research needs currently covered by the development projects.

### Main Acronyms

**MAI:** Ministry of Agriculture and Irrigation. **MOE:** Ministry of Education.

**AREA:** Agricultural Research and Extension Authority. **MSRC:** Marine Sciences and Resources Research Center. **FAUA:** Faculty of Agriculture, University of Aden. **FAUI:** Faculty of Agriculture, University of Ibb. **FAUS:** Faculty of Agriculture, University of Sana'a. **FAVUD:** Faculty of Agriculture and Veterinary Science of the University of Dhamar.

**YR:** Yemeni rial.

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**Table 1 - The National Agricultural Research System (1996/97)**
*Italics*: Approximate data    *\*\**: Rounded numbers    *-*: Data not available    *\**: See footnotes

NARS Institutions				AR Graduate Scientific & Technical Staff (Units)			Potential Res. Years (pRY)		Total Budget (million YR)		AR Expenditures/Resources (E) (million YR)					
No	Name - Acronym (Head Office - Year Establishment)		Mandates AR Fields	Govern. Ministry	Nationals Total - (PhD, MS)		Exp.	Nat.	Exp.	Nat.	Ext.	Nat. E NE	Loan LE	For. E FE	Total E TE	
a	B		c	d	e	f	g	h	i	j	k	l	m	n	o	
1.1	Agricultural Research and Extension Authority Dhamar 1955,90		AR (60%) - (AD) All ext. fisheries	MAI	255	45, 68	19	153	11	180	575	140*	80*	300*	520	
2.1	Marine Sciences and Resources Research Center - Aden 1983		AR (50%) - (AD) Fisheries, aquaculi	MOF	46	5, 25		23		23	20*			20*		
1-2	Total Agricultural Research Institutes				301	50, 93	19	176	11	245	560	160	80	300	540	
3.1	Faculty of Agriculture, Sana'a University - Sana'a 1984		AHE - (AR*) All*	MOE	77	45, 8	0	19		15		3			3	
3.2	Faculty of Agriculture, Aden Un., Aden FAUA, 1975		AHE - (AR*) All*	MOE	60	42, 15	12	15	4	30	120	6		10*	16	
3.3	Faculty of Agric. & Vet. Science, Ibb Univ - Ibb* 1996		AHE - All*	MOE	0*		0*	0	0	15		0			0	
3.4	Fac. of Vet. Science, Univ. Dhamar - Dhamar* FAVUD, 96		AHE - An. prod./health	MOE	0*		0*	0	0			0		0	0	
3	Total 4 Faculties of Agricultural Sciences				137	87, 23	12	34	4	60	120	10*		10	20*	
4	Other Scientific Institutions (see Section 2.4)				...	...	...	...	...	...	...	...	...	...	...	
5	Development Projects Involved in AR (see Section 2.4)				...	...	...	10	10	...	...	10	180*	10*	200	
6	Total NARS				438	137, 116	31	220	25			180	260	320	760	
Exchange Rate: Yemeni riyals (YR) 1000 = US\$ 8 or US\$ 1 = YR 125 (1997 average official rate)					Actual Research Years (aRYs) (rough estimate)					165	AR Expenditures (US\$ million) →		1.4*	2.1*	2.6*	6.1*

MAI: Ministry of Agriculture and Irrigation MOE: Ministry of Education MOF: Ministry of Fisheries

c. **Mandates**: AR (%): Approximate average % of human resources devoted to ag. research (AR), R: Research; AHE: Ag. higher education, AD: Ag. development/services (for AR and AHE institutes, seed production, extension, studies, etc.) h. i. Potential research-year (pRY) = equivalent full-time researcher, for the FASs, the pRYs have been estimated by multiplying the number of academic staff by 0.25. 1. For the AR institutes, AR financial resources have been roughly estimated through the following formula: Total budget × [(a + 0.5(100% - a))], as being the % of time devoted to AR by the graduate staff.

\* **Notes** 1.1m. Assuming that 60% of the World Bank loan (through the Agricultural Sector Management Support Project) is allocated to AR activities and 40% to extension. 1.1n. Grants estimated at national cost. Estimated by evaluating the salary costs of the expatriates on the basis of the average salary costs of a national graduate staff (estimates made assuming that around one-third of the grants is allocated to the salary costs of the expatriates). 3.3a and 3.4e, g. FAUI and FAVUD has no permanent academic staff, lectures are provided by academic staff of FAUA and FAUS (see monograph).

National AR expenditures (NE) 0.16% of the Agricultural Gross Domestic Product (AGDP, US\$ 0.9 billion in 1996). National expenditure + loans 0.39 % of the AGDP. Total AR expenditures (TE) 0.68% of the AGDP.

## **9. NARS IN THE WANA REGION: AN OVERVIEW AND A CROSS-COUNTRY ANALYSIS<sup>1</sup>**

### **9.1 HISTORICAL BACKGROUND**

- 9.1.1 Distant History
- 9.1.2 Recent Evolution

### **9.2 THE CURRENT NARS STRUCTURE**

- 9.2.1 Relative Importance of the Main Categories of NARS Institutions
- 9.2.2 Degree of Concentration/Fragmentation of the NARSS
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### **9.3 NARS RESOURCES**

- 9.3.1 Overview of the NARS Human Resources
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- 9.3.3 Cross-Country Comparisons of the NARS Human and Financial Resources
- 9.3.4 The NARS Physical Resources

### **9.4 RESEARCH ACTIVITIES AND RELATIONS WITH DEVELOPMENT**

- 9.4.1 Research Activities
- 9.4.2 Relations with Development

### **9.5 CONCLUSION**

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The analysis in this chapter is based mainly on the monographs of the 18 NARSs of the WANA region, presented in Chapters 4 to 8, and the methodology used for their preparation (Chapter 3). After a brief introductory section related to the historical background of agricultural sciences and agricultural research (AR) in the region, the chapter stresses successively on the structure of the NARSs and their resources, with cross-country comparisons of their human and financial resources, then their research activities and relations with development.

## 9.1 HISTORICAL BACKGROUND

### 9.1.1 Distant History

“Agriculture has never been discovered nor invented” (Harlan); it resulted from a very long evolutionary process which began during the Neolithic era in several *Homo sapiens* groups or societies. For millennia, technical advances have resulted from the observation sense and from the imagination and creativity of farmers, raisers and craftsmen. Very early on, agricultural and livestock practices have included selection of crop and animal species and races; over generations, techniques of cultivation, irrigation, fertilization, animal selection and husbandry, transport, etc. have slowly improved. Farmers, raisers and peasant communities, who lived largely in autarchy, were at the same time centers of genesis and adoption of technical innovations.

The Near East is considered among the most ancient (10000 to 9000 BC) and among the richest of agricultural centers of origin (origin of wheat, barley, lentils, goats, sheep, donkeys, etc.).<sup>1</sup>

In this region, Egypt is the country with the most ancient and developed agriculture. Cereals (barley, wheat, black millet: ‘*durra*’) were cultivated in 8000 BC; oxen were raised even earlier (coming probably from the African origin centers). Agriculture was well organized as early as 6000 BC. Throughout the pharaonic dynasties (around 3000 to 330 BC), “farmers invented and/or improved various agricultural tools and implements (hoe, reaper, yoke, draw-well, now called *shaduf*, etc.); dug canals and founded dykes and dams; reclaimed lands; knew ‘surveys’ as a science to draw maps for agricultural lands and ownership; and gave special attention to animal medical treatment, fattening and selection” (Erman A.). Dignitaries used to have gardens and nurseries of flowers, medicinal plants, and incense around their houses. Importing exotic plants, trees, and animals from other countries for local adaptation and crosses was frequent. Few and fragmented contemporaneous Egyptian texts are available on agriculture during that time; however, many wall paintings in tombs and monuments and very old objects<sup>2</sup> testify its development, as well as some Greek texts written before or after the conquest of the country by Alexander (Manniche L.).<sup>3</sup>

Later, Assyria (1900 to 539 BC: conquest by Darius) and Persia (625 to 330 BC: conquest by Alexander) had also known a highly flourishing agricultural era, as proven by the richness of *The Assyrian Herbal*<sup>4</sup> and by the numerous Persian names of plants and trees preserved later by the Arabs.

The Greek civilization may have received its agricultural knowledge mainly from Egypt. Testimonies of the level of this civilization are found in books written by Theophrastus, Kastos, and other authors.<sup>5</sup>

A rather large amount of literature exists on agriculture of the Romans after they took over the Greeks. The best-known authors and erudites during that time are the Latin agronomists Caton (2nd Century BC), Varro (1st Century BC), Columelle (1st Century AD), Palladius, and Vegece.

<sup>1</sup> Among the other main centers are New Guinea (10000 BC; taro and pigs), China (8500 BC; millet, cabbage, hens, pigs, oxen, etc.), Central America (9000–4000 BC; corn, beans, tomatoes, cotton, turkey, geese, etc.), South America (6000 BC; potatoes, quinoa, lama, etc.), and others.

<sup>2</sup> The Ancient Egyptian Agricultural Museum in Giza, Egypt, gathers the largest agricultural antiquity collection in the world, including plants, animals, tools, implements, materials/cloths, etc.

<sup>3</sup> Among them are Herodotus (5th Century BC), Theophrastus (4th Century BC), and Dioscorides (1st Century AD).

<sup>4</sup> Campbell Thompson R. published his books *The Assyrian Herbal* (1924) and *Dictionary of Assyrian Botany* (1949), based on the material available at the time (cuneiform tablets), dating to the end of the Second Millennium BC, with reference to some Sumerian texts from the Third and Second Millennia (see Manniche L.).

<sup>5</sup> Theophrastus: *Historia Plantarum et Causis Plantarum* (470 BC), a treatise of crop physiology and cultivation considered as rather remarkable for that time; Kastos: *The Book on Greek Agriculture (Kitab-al-felahah-ar roumiah)* (Clément Mullet).

Ancient India has played a crucial role in agricultural development in the region (and also in Eurasia and Africa). A large number of crops of diverse origin (China, Southeast Asia, East Africa, etc.) passed through India where they were often “ennobled,” then moved to the pre-Islamic world. These transfers began early in the Second Millennium BC, gaining momentum during the First Millennium BC and continuing into the early centuries of the Christian era and even later, after the Arab conquest of the province of the Sind (711 AD) (Watson).

After the rise and spread of Islam and the conquest of Persia (7th Century), there was much movement of men, goods, technology, information, and ideas (including movement for pilgrimages to Mecca). After a very short time, most regions of the Islamic world showed an astonishing mixture of people.

Arab rulers played a leading role in the advancement of agriculture and many other domains. They often competed with one another in patronizing learning, building palaces, and planting gardens. “Caliph residences and palaces often served as botanical gardens or experimental stations for setting and improving efficient agricultural techniques” (El Amami, in Ibn Al Awam, preface). Early caliphs in Baghdad and then Islamic rulers elsewhere were nearly all bibliophiles<sup>1</sup>. They collected books on a grand scale, sponsored ambitious programs of translation (from Greek, Syriac, Persian, Sanskrit, and Hindi). Amongst the books translated were a good number on agriculture and botany (Watson).

Available sources may have emphasized the role of these rulers, however, other agents were certainly very active. Muslim merchants, who had established merchant markets in all the caliphates and in other countries (India, China and East Africa), associating trade and missionary activities, used also to import plants and animals. Simple soldiers and peasants (Indians, Persians, Yemenis, Syrians, etc.), who migrated westward, may have carried not only these new plants but also the crucial techniques of growing them. Like men of religion, scholars—including many authors of Arabic manuals on farming, botany, and pharmacy—also traveled widely to study and teach (Watson).

Arab literature related to agriculture is abundant, with some authors well famed as Ibn Wahshiya (*Nabathean Agriculture*), Abou-Hanifih Al Dinouri (903 AD, from Dinour, a Persian town), Ben-Baqal (Abou-Abd-Allah-al-Andalisi, 1070), Hadj-Ahmed from Grenade (1160), and above all Ibn Al Awam (12th Century), an authentic scientist sponsored by the Caliph of Sevilla/Spain, author of *The Book of Agriculture* (12th Century), which is an updated collection of the agricultural sciences and practices accumulated in the Mediterranean region during that time<sup>2</sup>.

It is worth noting the prestige and fame of the farmers of Spain, especially of Andalusia, considered as the best at the time of the Arab apogee<sup>3</sup>. North African agriculture, previously rather isolated from the main advances reached in the Near East, benefited from this proximity and registered significant developments<sup>4</sup>.

With the Arab decadence and then the growth (14th to 17th Centuries) and decline (from the 18th Century to the First World War) of the Ottoman Empire, it seems that agriculture in the WANA region was subjected to relative stagnation. At that time, European countries started their economic development, which was marked by progressive industrialization, urbanization, labor division, and intensification of international circulation of products and ideas. There, industrial growth and social changes or revolutions launched at the end of the 18th Century further determined major changes in agriculture. Chemical and metallurgical companies originated the use of mineral fertilizers and more efficient plowing and harvesting tools, and the first agricultural schools and experimental farms were created by states and farmers’ organizations. In the 20th Century, a path in Europe and North America largely opened to the scientific revolution, which was accelerated after the Second World War in the developed countries. In these countries, agricultural innovations came mainly from research and research-development specialized units set up by public scientific institutions (particularly agricultural research institutes and faculties of agricultural sciences), agro-industrial enterprises (public and private, national and international), and farmers’ large associations.

<sup>1</sup> Marcus Terentius Varro, a very prolific author, wrote 74 books on diverse fields, one of which was on agriculture (*Rural Economy: Rerum Rusticarum Libri*); he also built the first libraries in Rome during the Cesar empire.

<sup>2</sup> Lucius Junius Columelle, a Roman born in Cadix, Spain, is the author of the *Treatise of Agriculture (De re rustica)*, which is very precise and rich book, considered as the most complete on Roman agriculture (12 volumes).

<sup>3</sup> The Fatimid caliph of Egypt, Al-Aziz (dead in 996), had a library which contained between 120,000 and 160,000 volumes. By the time of Al-Hakam II (961–976), the royal library in Cordoba, Spain, contained some 400,000 volumes.

<sup>4</sup> El Amami (in Ibn Al Awam, preface) mentions that this erudite remained almost ignored in the Arab countries and scientific communities; only the scientific publication *Al Awamia* of the Moroccan INRA brings his name.

<sup>5</sup> By Ibn-Khaldun (1332–1412) in *El-Muqaddima. Discours sur l’histoire universelle* (see Bessaoud).

<sup>6</sup> Bessaoud testifies this stand, quoting some Arab geographers who gave a precise description of the countryside, farming systems, and urban food markets in the Maghreb region (Hassan El-Wazan, called Leon the African, 977; Al Bekri, 1068; Al Idrisi, 1150; etc.).

### 9.1.2 Recent Evolution

The evolution of developing countries began much later in the WANA region, except in Turkey and Egypt, countries which were fully or partly independent during the 19th Century. Graduate agricultural schools were opened in Istanbul in 1842 and 1881 (for veterinary medicine and agriculture, respectively) and in 1869 in Cairo. In Egypt, the first Directorate of Agriculture was created in 1875 and the Egyptian Royal Academy supported the establishment of some experimental farms in 1897. Also, at the end of the 19th Century, the first public agricultural institutions were established under the French rule in Tunisia (Animal Production Service in 1887, Colonial School of Agriculture in 1889) and in Algeria (*Institut Agronomique d'Alger*, for technician training, in 1898).

In the first half of the 20th Century (till the end of the Second World War in 1945), initiatives were much more numerous, particularly in the largest countries.

- In Egypt, under the British mandate (until 1922), these initiatives included the establishment of the Ministry of Agriculture (1913), the Cotton Research Council (1919), and 10 specialized research stations or laboratories considered as the origins of 10 AR institutes (ARI) governed by the present huge ARC. After independence in 1922, the new institutions were the Alexandria (research) Institute of Hydrobiology (1927), the father of the existing NIOF<sup>1</sup>, and the Faculties of Agriculture and Veterinary Medicine of Cairo (1935).
- In Turkey, only two veterinary research centers were established in 1914 and 1921. After the establishment of the Republic in 1925, attention to agricultural sciences was remarkable (15 ARIs were founded all around the country and one graduate agricultural school at Ankara).
- Iran advanced quickly, under Razi Shah government (1925–1941), with the establishment of the Razi Serum Research and Production Institute (1925, still operating), the Agriculture College, Karaj (1926), the College of Veterinary Medicine, Tehran (1933), and three ARIs specialized in animal production, sugar beet, and tobacco (from 1933 to 1937).

Among the countries under the rule of European countries, attention to agricultural sciences varied according to colonial and colonized countries, with a generally higher preference by the former to export commodities.

- Among countries under British rule, Sudan received a preferential treatment (due to its high agricultural potential) concretized by the creation of, first, some cotton experimental farms (1902–1903) and the Central Veterinary Research Laboratory (1903); then the Gezira Research Station (1918), which became the headquarters of the AR Service (1931) and of the current ARC; and the Schools of Agriculture and Veterinary Medicine at Shambat/Khartoum (1938). In other countries, it is worth to mention the establishment of some experimental farms in Iraq, Bahrain and the United Arab Emirates, respectively in the 1920s, 1930s, and 1940.
- Among the francophone countries, Morocco acquired the *Jardin d'Essai* (botanical garden) of Rabat (1916), which currently hosts INRA headquarters; a research station for forestry (1934); and the graduate National Agricultural School of Meknès (1940, almost reserved for French farmers' sons). In Tunisia, the *Service Botanique* of Tunis (1913), the father of the existing INRAT, hosted a good number of well-known French agronomists working also for Algeria, where a few agricultural stations were established during that period. In Syria, there were only a few experimental farms around Damascus established in the last years of the French mandate (1946).
- Contribution of Italy to agricultural development (of Italian colonies) was limited to a few experimental stations in Libya (Centro sperimentale agrario e zootecnico della Libia, near Tripoli) and Eritrea.

The period 1945–1989 was the apogee of development of the NARSs in the WANA region, marked by the creation of most of the existing present institutions.

The largest countries kept their lead. In Egypt, 20 ARIs out of the 24 run by ARC were created, most of them through restructuring of already existing AR units, and ARC was established in 1983 for coordinating these institutes. Other main NARS institutions were created, such as the Desert Research Center (1950) and the National Research Center (1956), and 20 new faculties of agricultural sciences (FASs, including faculties of agriculture and faculties of veterinary medicine) were founded in the country (11 in 1950–1963 and 9 in 1964–1989). In Turkey, the period saw the creation of 47 ARIs and more than 40 FASs. In Iran, this period was also highly prolific, both under the Shah's rule (7 new ARIs, 15 new colleges) and after the proclamation of the Islamic Republic in 1979 (4 ARIs and 7 FASs), with an obvious priority given to higher education.

<sup>1</sup> See the acronyms of the still-existing national NARS institutions at the end of the chapter.

Some medium-size countries also registered such relative prolificacy. After independence in Algeria (1962), AR was conducted at INRAA (1966), then at 12 specialized development-research institutes, and 11 FASSs were created. In Tunisia (independent in 1956), INRAT took over an existing AR unit in 1961, and 10 other agricultural scientific institutions were founded (2 ARIs and 8 FASSs). In Syria, 6 directorates affiliated to the Ministry of Agriculture, mainly involved in AR activities, were established during the period 1952–1977 (including the largest one: DASR, 1964), and the creation of the FASSs of Aleppo and Damascus (1960) was followed by that of 3 other FASSs.

Other medium-size countries made other choices. In Morocco (independent in 1956), INRA took over the existing AR Service in 1962, and the Agriculture and Veterinary Institute (IAV Hassan II/Rabat), a graduate education institution, was established in 1966. In Sudan, AR remained centered mainly at ARC, and 7 new FASSs were created. Iraq followed a rather similar path, with a main ARI (SBAR, 1980), and 2 colleges of agriculture and veterinary medicine opened by the University of Baghdad in 1952 and, later, 3 other FASSs. In Yemen, South and North had their own AR stations and FASSs (Aden, 1975; Sana'a, 1984) till they merged into one country (1990).

Small countries developed their NARSSs during this period. Libya (independent in 1951) started with the FAS of Tripoli (1966), ARC (1970), and then 3 new FASSs. The Jordanian NARS began with some research stations managed by a directorate in charge of research and extension, taken over in 1985 by NCARTT, the current dominant national ARI; in addition to 2 FASSs established by the Universities of Amman and Irbid (1970, 1986). Lebanon opened its first AR station in Tel Amara in 1946 with French support, which became LARI in 1964; while 4 FASSs were established, the first by the American University of Beirut in 1952, with its Agricultural Research and Education Center (AREC) in the Bekaa Valley. In Bahrain (independent in 1971) and the United Arab Emirates (UAE) (established in the same year), AR was undertaken mainly by the existing stations and by ministry directorates; and one FAS was created by the UAE University in 1980.

The last 10 years (1990–1999) were dedicated to restructuring in the largest countries. In Egypt, ARC received for its modernization very large support from the Government and USAID (mainly a grant of US\$ 205 million for 10 years), and 4 new FASSs were added. In Iran, most of the numerous ARIs (including 13 new ones) were affiliated to two large organizations under the Ministries of Agriculture (AREEO under MOA) and Jihad Construction (MOJC), and no new FASSs were created. In Turkey, 6 new ARIs were established but most of the numerous ARIs were regrouped under the General Directorates of AR (GDAR) and of Rural Services (GDRS), and 9 new FASSs are being established. Ethiopia decided in 1997 to merge its ARIs into one organization, EARO, responsible for the national AR policy.

In the medium-size countries (Algeria, Iraq, Syria), there were few changes. In Morocco, it was a time of consolidation and growth of the existing NARS institutions. In Tunisia, the Ministry of Agriculture established IRFSA as responsible for its research and higher education policy. In Yemen, one single ARI, AREA, was created for all the country, and two new FASSs were added.

In the small countries, the addition of three new FASSs in Jordan is worth mentioning. In Eritrea (independent in 1991), one college of agriculture (CAAS, 1992) and one directorate in charge of AR (DART, 1992, named as DAHRD in 1997) were established.

## 9.2 THE CURRENT NARS STRUCTURE

The analysis of the current structure of the NARSSs is concerned with the relative importance of the three categories of NARS institutions, the degree of fragmentation/concentration of the NARSS—a concept related with the nature, number and size of institutions making up the NARSS—and the degree of integration of the NARSSs, related with the national AR governing organizations.

### 9.2.1 Relative Importance of the Main Categories of NARS Institutions

Table 1 on the relative importance of the three main categories of scientific and technical institutions (STIs) of the NARSSs shows:

- The major role of the ARIs which mobilize (on average for all the WANA region) around 62% of the total potential research years (pRYs or full-time researchers) and 78% of the total financial resources (see Sections 9.3.1 and 9.3.2).
- The relative importance of the scientific potential of the FASSs (23% of the total pRYs) and their limited financial capacity (7% of the total financial resources). However, in many countries, a good number of academic staff members are working in research programs implemented by ARIs and other NARS institutions, taking advantage of the financial resources of those institutions.
- The considerable contribution of the other NARS institutions (around 15% of the total pRYs and total financial resources) which, no doubt (as said before), is slightly underestimated.

**Table 1 - Structure of the WANA NARSs: Categories of Institutions (1996–1998)**

ARIs: AR Institutions. FASs: Faculties of Agricultural Sciences. OIs: Other institutions.

\*: Total without the NARSs of Iraq and the United Arab Emirates (no available data on their financial resources).

Country/ Sub-Region	AR Potential Research Years (pRY)				AR Expenditures (E)			
	Total NARS (units)	Breakdown per category of institutions (% of total)			Total NARS (US\$ million)	Breakdown per category of institutions (% of total)		
		ARIs	FASs	OIs		ARIs	FASs	OIs
1 Algeria <sup>a</sup>	575	7	27	66	13.7	13	21	66
2 Libya	261	50	38	12	13.1	73	9	18
3 Morocco	606	64	18	18	40.3	63	12	25
4 Tunisia	368	61	25	14	15	72	15	13
<b>A North Africa</b>	<b>1813</b>	<b>43</b>	<b>25</b>	<b>32</b>	<b>82.1</b>	<b>58</b>	<b>14</b>	<b>28</b>
5 Egypt	6710	57	22	21	67.6	77	6	17
6 Eritrea	61	77	23		1.8	78	22	
7 Ethiopia	475	86	14	<sup>a</sup>	8.3	97	3	<sup>a</sup>
8 Sudan	595	67	29	4	3.1	92	6	2
<b>B Nile Valley/Red Sea</b>	<b>7841</b>	<b>59</b>	<b>22</b>	<b>19</b>	<b>80.8</b>	<b>80</b>	<b>6</b>	<b>10</b>
9 Cyprus	40	100			5.5	100		
10 Iraq	770	32	49	19	...	...	...	...
11 Jordan	198	67	25	8	6.1	79	18	3
12 Lebanon	83	65	28	7	3.8	88	11	1
13 Syria	1058	66	19	15	15.3	70	5	25
<b>C West Asia</b>	<b>2149</b>	<b>55</b>	<b>30</b>	<b>15</b>	<b>30.7*</b>	<b>79*</b>	<b>8*</b>	<b>13*</b>
14 Iran	3610	87	11	2 <sup>b</sup>	98.7	93	5	2 <sup>b</sup>
15 Turkey	2288	52	37	11	110.7	78	4	18
<b>D Highlands</b>	<b>5898</b>	<b>73</b>	<b>21</b>	<b>6</b>	<b>209.4</b>	<b>86</b>	<b>4</b>	<b>10</b>
16 Bahrain	32	66		34	3.2	73		27
17 United Arab Emirates	73	77	18	5	...	...	...	...
18 Yemen	245	76	16	8 <sup>b</sup>	6.1	70	4	26 <sup>b</sup>
<b>E Arabian Peninsula</b>	<b>350</b>	<b>75</b>	<b>15</b>	<b>10</b>	<b>9.3*</b>	<b>71*</b>	<b>17*</b>	<b>12*</b>
<b>F Total WANA</b>	<b>18051</b>	<b>62</b>	<b>23</b>	<b>15</b>	<b>412.3*</b>	<b>78*</b>	<b>7*</b>	<b>15*</b>

a: Algeria: approximate data. b: Ethiopia, Iran, and Yemen: Resources of OIs are most likely underestimated.

Source: Ratios calculated from Tables 5 and 9.

These global features are valid in most of the countries with few noticeable exceptions: Cyprus is the single country having only one institution (an ARI), while Eritrea and Bahrain have no “other institutions” (OIs) and FASs, respectively. Iraq is remarkable for the very large importance of the FAS human resources (49% of the pRYs). Algeria is the only country in the region with relatively strong ARIs: the most important NARS institutions are agricultural “development–research institutes” which allocate a prominent part of their resources to development and service activities (seed production, extension, soil analysis, etc.) and are therefore classified as OIs. In Morocco, Tunisia and Jordan, FASs enjoy relatively better financial resources than in the other countries.

### 9.2.2 Degree of Concentration/Fragmentation of the NARSs

A NARS is considered to be concentrated when it is comprised of a number (small or large) of large scientific and technical institutions (STIs) and, on the other hand, fragmented when it is made up of a large number of small STIs; the magnitude of both number and size is relative to the size of the NARS itself.

The appreciation of the degree of concentration/fragmentation of a NARS relies on the assessment of the nature, number, and size of institutions making up the NARS<sup>1</sup>. Table 2 gives an idea of this degree through the relative importance of the financial resources of the two largest STIs of each NARS<sup>2</sup>, which leads to a conventional classification of the NARSs into five categories:

- “Very highly concentrated” NARS: Cyprus, Ethiopia and Lebanon, where the two largest STIs mobilize more than 88% of the NARS financial resources.
- “Very highly fragmented” NARS: Algeria, where this percentage is only 15%.
- “Highly concentrated,” “rather concentrated,” or “rather fragmented” NARS, where the largest or the two largest STIs mobilize intermediate percentages of the NARS financial resources.

This initial classification does not imply a categorical judgment of the NARS structure. At this stage, it may be worth mentioning the disadvantages often met in fragmented NARSs, such as: competition between STIs for allocation of human, physical, and financial resources; high costs implied by the multiplicity of directorates and services, experimental farms, libraries, etc.; overlapping or gaps in research programs; and relative isolation of scientists in small STIs. But a country with a NARS with efficient governing bodies and good communication/information services could overcome these weaknesses and exploit the acknowledged benefits of small institutions, i.e., easier management; greater dynamism; proximity to users for STIs having a specific or commodity mandate; etc. We will now see that this is not the case throughout the WANA region.

### 9.2.3 Degree of Integration of the NARSs

The degree of integration of a NARS refers to the capacity of the political and administrative authorities concerned to define and implement through the NARS STIs a national AR policy adapted to the social demands/needs and to the national and external resources available. According to this definition, the following is a discussion of the nature of these authorities and the consistence of their relations with the STIs.

#### Authorities Responsible for the National Scientific Research Policies and National AR Policies (Table 3)

The nature of the authorities responsible for national research and AR policies (formulation of the policies; main decision making related with resource allocation, STI structure and operation; etc.) is highly variable in the WANA region. Despite changes taking place throughout the years—as a result of changes of government or ministerial appointments—the current nature of these authorities is highly significant in terms of their way of managing the NARSs and their STIs.

<sup>1</sup> For some NARSs endowed with “multi-organizational” ARIs (such as IRESA in Tunisia, ARC in Egypt, etc.), the major issue related with this degree of concentration/fragmentation is the assessment of the nature of these ARIs and the actual status of the institutes within them (degree of autonomy: see Chapter 3, Section 3.2.2).

<sup>2</sup> As seen in Table 2, the largest STI is an ARI in all countries, and the second largest is also an ARI for half of the countries, an FAS in six countries, and an OI in one country (Egypt).

Table 2 - Structure of the WANA NARSs: Relative Size of the NARS Institutions (1996–1998)

a: ARI, AR Institute, ARI<sup>2</sup> ARI which governs a relatively large number of ARIs with limited autonomy (see notes), FAS: Faculty of Agricultural Sciences, OI: Other institution  
b: Degree of NARS concentration: VH: very high, H: high, m: medium, L: low, VL: very low c: Total without the NARSs of Iraq and UAE (no available data on their financial resources)

Country/ Sub-Region	Total AR Potential Res. Years (pRys)	Total AR Expend. (TE: US\$ million)	Number Ag. Sc. Institutions		A. Largest NARS Institution							B. Second Largest NARS Institution							A + B: % total		Degree of NARS Concentration <sup>d</sup>							
					Acronym	Status <sup>e</sup>		pRys		TE			Acronym	Status <sup>e</sup>		pRys		TE										
			Units	%				US\$ mil	%	Units	%	US\$ mil				%	pRys	TE	VH	H	M	L	VL					
1 Algeria <sup>a</sup>	575	13.7	2	15	INRA	ARI	Auto.	32	6	1.5	11	ENASA	FAS	Auto.	40	7	0.5	4	13	13								VL
2 Libya	264	13.1	3	7	ARC	ARI	Auto.	112	42	7.9	69	ASRC	ARI	Auto.	13	5	1	8	47	68								H
3 Morocco <sup>a</sup>	606	40.3	4	3	INRA	ARI	Auto.	270	45	18	45	INRH	ARI	Auto.	70	12	4.7	12	57	57								M
4 Tunisia <sup>a</sup>	368	15	6	8	INRA	ARI	S/auto.	73	20	3.8	25	IRA	ARI	Auto.	37	10	2.2	15	39	49								L
<b>A North Africa</b>	<b>1813</b>	<b>82.1</b>	<b>15</b>	<b>33</b>				<b>487</b>	<b>27</b>	<b>31.2</b>	<b>38</b>				<b>160</b>	<b>9</b>	<b>8.4</b>	<b>10</b>	<b>36</b>	<b>46</b>								
5 Egypt <sup>b</sup>	6710	67.6	3	26	ARC <sup>a</sup>	ARI	Auto.	3140	47	42	62	NRC	OI	Auto.	950	14	8	12	61	74								H
6 Eritrea	61	1.8	2	1	DARHED	ARI	S/auto.	27	44	1.1	60	CAAS	FAS	S/auto.	14	23	0.4	23	67	83								H
7 Ethiopia <sup>a</sup>	475	8.3	9	5	EARO <sup>a</sup>	ARI	Auto.	306	64	6.6	80	RARCs	ARI	Adm.	105	22	1.4	17	87	97								VH
8 Sudan	595	3.1	3	23	ARC	ARI	Auto.	212	36	1.9	62	ARRC	ARI	Auto.	146	23	0.7	22.1	70	84								H
<b>B Nile Val./R. Sea</b>	<b>7841</b>	<b>82.5</b>	<b>17</b>	<b>55</b>				<b>3685</b>	<b>47</b>	<b>51.6</b>	<b>64</b>				<b>1215</b>	<b>16</b>	<b>10.5</b>	<b>13</b>	<b>63</b>									
9 Cyprus	40	5.5	1		ARI/C	ARI	Auto.	40	100	5.5	100								100	100								VH
10 Iraq <sup>c</sup>	770	...	2	8	SBAAR	ARI	Auto.	200	26	...	...	CA-Baghd	FAS	S/auto.	127	17	...	...	43	...								M
11 Jordan	198	6.1	3	5	NCARTT	ARI	Auto.	121	61	4	66	FA/Amn	FAS	S/auto.	20	10	0.6	10	71	76								H
12 Lebanon	83	3.8	2	4	LARI	ARI	Auto.	44	53	3.2	85	NCMS	ARI	S/auto.	10	12	0.1	3	65	88								VH
13 Syria	1058	15.3	7	6	DASR	ARI	Adm.	378	36	5.1	33	DS	ARI	Adm.	129	20	2.7	19	56	55								M
<b>C West Asia</b>	<b>2149</b>	<b>30.7</b>	<b>15</b>	<b>23</b>				<b>783</b>	<b>37</b>	<b>17.8</b>	<b>58</b>				<b>286</b>	<b>13</b>	<b>3.4</b>	<b>11</b>	<b>50</b>	<b>60</b>								
14 Iran <sup>d</sup>	3610	98.7	2	24	R/MOJC <sup>d</sup>	ARI	Auto.	1576	44	47	48	AREEO	ARI	Auto.	1399	39	38	39	83	86								H
15 Turkey <sup>a</sup>	2288	110.7	4	52	GDAR <sup>a</sup>	ARI	Adm.	881	39	60.9	55	GDRS	ARI	Adm.	143	7	17.1	17	46	72								H
<b>D Highlands</b>	<b>5898</b>	<b>209.4</b>	<b>6</b>	<b>76</b>				<b>2457</b>	<b>42</b>	<b>107.9</b>	<b>52</b>				<b>1542</b>	<b>26</b>	<b>55.1</b>	<b>26</b>	<b>68</b>	<b>78</b>								
16 Bahrain	32	3.2	2		ARD	ARI	Adm.	11	35	1.5	47	FD	ARI	Adm.	10	31	0.8	26	66	73								H
17 UA Emirates	73	...	5	1	ARD	ARI	Adm.	34	46	...	...	FAS	FAS	S/auto.	13	18	...	...	64	...								M
18 Yemen	245	6.1	2	4	AREA	ARI	S/auto.	164	67	4.2	68	FAUA	FAS	S/auto.	19	8	0.2	3	75	71								H
<b>E Arab. Penins.</b>	<b>350</b>	<b>9.3</b>	<b>9</b>	<b>5</b>				<b>209</b>	<b>60</b>	<b>5.7</b>	<b>61</b>				<b>29</b>	<b>11</b>	<b>1</b>	<b>11</b>	<b>74</b>	<b>72</b>								
<b>F Total WANA</b>	<b>19051</b>	<b>412.3</b>	<b>62</b>	<b>192</b>				<b>7621</b>	<b>42</b>	<b>214.2</b>	<b>52</b>				<b>3252</b>	<b>18</b>	<b>81.4</b>	<b>20</b>	<b>60</b>	<b>72</b>								

d: Algeria: Approximate data. e: Morocco: IAV, a FAS with 79 pRys and US\$ 4.5 million for AR, has around the same AR resources as INRH. f: Tunisia: IRISA oversees 4 ARIs and 9 FASs (222 pRys and US\$ 7.7 million, i.e., 60% of the pRys and 54% of the financial resources of the NARS), each one with rather large autonomy. g: Egypt: ARC has 24 ARIs and Central Labs. h: Ethiopia: EARO has merged 7 ARIs in 1998. i: Iraq: Ag. and biological centers of the Iraq Atomic Energy Center (around 100 pRys) may have much larger financial resources than the Baghdad College of Ag., these centers and SBAAR may be mobilizing more than 60 or 70% of the NARS financial resources. j: Iran: 7 ARIs governed by the MOIC Research Directorate, and 12 ARIs governed by AREEO. k: Turkey: GDAR and GDRS have 55 and 11 ARIs, respectively.

**Table 3 - Structure of the WANA NARS: Degree of Integration**

Country	National Authorities Responsible for Research Policy					National Authorities Responsible for AR Policy (Coordinating body: CB)							Relations among Main ARIs <sup>c</sup>			Relations ARIs – FASs <sup>d</sup>			NARS Coverage of Regions in the Country <sup>e</sup>			Degree of Integration			
	Nature		Impact on AR policy			The nat. research authority (= a or b)	One specific NARS CB	CB within Min. of Agric.		CB later Minister or STB	Formal CB power at NARS level			Good	Moderate	Weak	Good	Moderate	Weak	Well balanced	Moderately balanced	Very unbalanced	High	Moderate	Weak
	Specialized Body <sup>a</sup>	Ministry HEIR <sup>b</sup>	High	Medium	Weak			Specific CB	ARI		High	Medium	Weak												
Algeria		MESRS		x				DFRV				x			x			x			x			x	
Libya		NASR			x			NASR					x			x			x					x	
Morocco		MESRS			x			DERD					x					x						x	
Tunisia		SERST			x			SERST		IRESA			x				x		x					x	
Egypt		MBRT			x			NARC					x			x		x			x			x	
Eritrea		No								x		x				2 ARIs (ag+fish)		x			x			x	
Ethiopia		No								EARO		x				EARO lag. dom.			x				x		
Sudan		MEHSR			x				ARC				x					x			x			x	
Cyprus		No							ARI			1 ARI alone		1 ARI alone			No FAS			x			x		
Iraq		MEHSR			x			MEHSR	SBAAR			x				x		x						x	
Jordan		HCST			x				NCARTT				x				x			x				x	
Lebanon		NCSR			x			NCSR	LARI				x			2 ARIs (ag+fish)			x					x	
Syria		SCS			x			SCS					x					x		x				x	
Turkey		STRCT			x			STRCT	GDAR				x				x		x					x	
Iran		NCSR			x			NCSR					x					x			x			x	
Bahrain		BCSR			x			BCSR					x			2 ARIs (ag+fish)		No FAS		x <sup>9</sup>				x	
U.A. Emirates		MEHSR			x			MEHSR				x					x		x					x	
Yemen		No							AREA				x			2 ARIs (ag+fish)				x				x	

a. Specialized governmental body (ministry, council, etc.). b. Ministry of Higher Education and Research. c. Concrete AR relations (joint programs and resources) among ARIs involved in the same large fields (agriculture or fisheries). d. Concrete AR relations between ARIs and FASs. e. NARS coverage of the large agroecological zones of the country (with permanent qualified staff and physical resources allocated in these zones), with three scales: well balanced, moderately balanced and very unbalanced.



### Authorities Responsible for the National Scientific Research Policies

At present, some countries have a ministerial authority specifically (and only) in charge of research (and technology), these are: Egypt, which has a ministry, and Bahrain, Iran, Jordan, Lebanon, Libya, Syria, Tunisia, and Turkey, which have a specific national authority generally directly affiliated to the Prime Minister<sup>1</sup>. The role of these ministerial authorities is decisive in terms of some general aspects affecting all research institutions (statutes/rules of the institutions, nominations of their leaders jointly with the concerned governing ministries, career scheme and salaries of researchers and other staff, etc.). Regarding the AR policy, the role of these authorities is:

- relatively strong in Iran, Lebanon, and Tunisia: in these countries, the ministerial authorities have set up one or several AR commissions, generally composed of representatives of the ministries and main STIs concerned, which play an effective role in the formulation of the national AR policies and fund allocation; in addition, they are directly involved in the NARS as a governing authority of some NARS STIs (Tunisia and Lebanon);
- rather weak in Bahrain, Egypt, and Turkey (limited role in the formulation of national AR policies; no financial resources)

In a few countries (Algeria, Iraq, Morocco, Sudan, and UAE), ministries of higher education and research are in charge of research, often through a specific directorate or unit. Generally, the power of these ministries is effective only over the NARS STIs working under their umbrella (most of the FASs<sup>2</sup> and sometimes some OIs), and very limited over the NARS STIs affiliated to other ministries.

### Authorities Directly Responsible for the National AR Policies

Only Egypt has a specific body responsible for the national AR policy. There, the National AR Council (NARC), established by the Ministry of Agriculture and Land Reclamation (MALR) and chaired by the MALR Minister, is composed of representatives of the heads of the main NARS STIs affiliated to MALR and to other ministries. NARC has the mandates at the national and regional levels for (i) designing the general policies for AR plans, programs and projects in different research disciplines, (ii) investigating methods for funding and supporting them, and (iii) integrating and coordinating between them, and monitoring them.

In the other countries, responsibility for the national AR policy remains split among the ministries which directly govern the NARS STIs (ministries of agriculture, fisheries, higher education, research) with different situations:

- In Iran, Lebanon, and Tunisia, as seen above, there is rather good coordination among these ministries through the authorities responsible for the national research policy.
- In Eritrea and the United Arab Emirates, coordination between the ministries of agriculture and higher education or their representatives has been established on an egalitarian basis<sup>3</sup>.
- In some countries, the ministries of agriculture (MOAs) succeeded in making other ministries acknowledge the predominant ARI under their governance as responsible for the national AR policy, either officially as in Cyprus (ARI/C), Ethiopia (EARO), and Jordan (NCARTT), or *de facto* as in Lebanon (LARI), Sudan (ARC), Turkey (GDAR), and Yemen (AREA).
- In other countries, there is no actual coordination between the ministries concerned; however, the MOAs, which are generally the ministries more involved in AR, try to coordinate NARS institutions under their umbrella in different ways:
  - In Algeria, Morocco and Tunisia, the monitoring of these institutions is operated by administrative units (DFRV, DEDR and IRESA, respectively), whose mandates also cover education and extension and rely mainly on encouraging collaboration between the concerned organizations. The role of these units in the national AR policy is relatively significant only in Tunisia where IRESA is endowed with important human and financial

<sup>1</sup> The Libyan National Authority for Scientific Research, the Tunisian Secrétariat d'Etat à la Recherche (SERST), the Lebanese National Center for Scientific Research, the Jordanian High Council for Science and Technology, the Syrian Supreme Council for Sciences, the Iranian National Council for Scientific Research, the Scientific and Technical Research Council of Turkey (STRCT), and the Bahrain Center for Studies and Research (BCSR).

<sup>2</sup> Most of the FASs in Algeria, Morocco, and Tunisia are under the umbrella of the ministries of agriculture.

<sup>3</sup> In Eritrea, the unique ARI (DARHRD) and FAS (CAAS) have developed a strong formal relationship (steering committee and task force) under the umbrella of their respective governing bodies (Ministry of Agriculture and the University of Asmara). In the United Arab Emirates, a coordination committee between the ministries of agriculture and higher education/research has been recently set up for coordinating national AR activities.

resources, moderate in Morocco, and weak in Algeria where DFRV has limited resources and where the NARS institutions under MOA are the minority (less than 50% of the human and financial resources of the NARS);

- In Syria, where the main ARIs are directorates of MOA, there is no specific formal research coordination body (coordination insured through periodic meetings of the directorate heads, chaired by the Deputy Minister).

### **Linkages among the NARS Institutions and their Territorial Coverage**

According to their nature and effectiveness, the national AR authorities differ in their impact on the relations between the NARS ARIs, the relations between the ARIs and FASs, and the coverage of the national agroecological regions.

Effective linkages between the NARS institutions are often rather weak, both among the ARIs and between the ARIs and the FASs.

The issue of linkages between the ARIs is relevant only for NARSs endowed with several ARIs in the same large field (agriculture or fisheries), which excludes Algeria, Bahrain, Cyprus, Eritrea, Lebanon, and Yemen. It is of little importance in the NARSs that have a highly dominant ARI (Ethiopia and Jordan, where there are limited relations with the few other ARIs). For the other countries, concrete institutional linkages (joint research programs and resources) between the ARIs are moderate in Egypt, Iraq, and Tunisia, and almost nonexistent in the other countries (Iran, Morocco, Sudan, Syria, Turkey, and UAE) despite the fact that informal relations (between ARI leaders and researchers) are generally good. Most of the time, such few linkages are justified by the complementary mandates (for example, ARIs specialized in crops and others in animal production, or in crop/animal commodities and natural resources, such as soil or water), which would mean that every ARI works in its own field. However, complementary mandates generally call for scientific collaboration to obtain integrated results (see Section 9.4.1 on Research Activities). The most decisive factors which could explain the lack of collaboration between the ARIs might be the abundance of qualified human resources and/or the limited funds (for capital and operation) in most of them. It is remarkable to observe that collaboration between ARIs often exists or starts in programs funded by other bodies (external donors in Tunisia and Egypt; NCSR in Iran).

Concrete AR relations between ARIs and FASs are weak<sup>1</sup> in almost all the countries due to the above-mentioned factors (abundance of qualified human resources and limited funds in both sets of institutions) as well as to other specific factors (in particular, lack of time and professional and financial motivation of the academic staff in most countries; large differences in social/salary conditions between researchers and academic staff members). However, those relations are moderate and often based on personal commitment of the academic staff members in Egypt, Jordan, Lebanon, Morocco, and Tunisia, probably because of specific aspects of the national environment (mainly, relatively good salaries of both the researchers and the academic staff, research activities/achievements taken into consideration in the academic staff's career; external funds available). Relations seem good only in Eritrea, certainly due to pressure from the national authorities and donors.

It is worth to briefly mention the relations between ARIs and "other institutions" (OIs), which are rather significant only in Algeria (see Section 9.2.1). In Yemen, it seems that AR activities within development projects are concerned mostly with regions and scientific fields (mainly natural resources) that are poorly covered by its main NARS institution, AREA, and the FASs.

Territorial coverage of the NARS refers mainly to the presence of permanent qualified staff and, secondly, to the available physical resources in the large agroecological/administrative zones of the country. This issue is particularly relevant in medium and large countries (in terms of area and agroecological diversity).

Territorial coverage is rather well balanced and satisfactory in Eritrea, Ethiopia, Iraq, Syria, and Turkey, and rather satisfactory in Iran, Libya, and Morocco. In Algeria, Egypt, Sudan, Tunisia, and Yemen, relatively large numbers of researchers and academic staff members are concentrated in and around the capital and in the most favored agricultural zones.

These degrees of "regional integration" are essential for the relations between the NARS STIs and development organizations (see Section 9.4.2).

<sup>1</sup> In most of the countries, relations in other domains are often considered satisfactory: FASs are directly involved in graduate training of young researchers; academic staff members and, often, ARI researchers assist students in their diploma studies.

#### 9.2.4 A Tentative Structural Typology of the NARSs

Table 4, which combines elements of Tables 2 and 3, proposes a tentative typology of the NARSs according to their size and structure.

Among the small NARSs, those of Cyprus, Eritrea, and Lebanon are very concentrated or at least concentrated and well integrated. The Jordanian and Libyan NARSs are concentrated and moderately integrated, while the Bahrain and UAE NARSs are concentrated or rather concentrated but not integrated.

All the medium NARSs are moderately integrated and more or less concentrated, with different situations regarding regional integration. Sudan and Yemen enjoy the best situation among this group. The Algerian NARS is facing the most acute structural problems in the WANA region.

Among the larger NARSs, the Ethiopian is now well shaped with the recent creation of EARO. The Egyptian, Iranian, and Turkish NARSs are concentrated and moderately integrated.

Finally, this structural analysis confirms the large diversity of the NARS situation in the WANA region. Each country has a specific structural profile with only few similarities among the different countries.

### 9.3 NARS RESOURCES

Following is an overview of the human and financial resources of the 18 NARSs, with a cross-country comparison of these resources and some information on the material resources.

#### 9.3.1 Overview of the NARS Human Resources

This section deals with the numbers and qualifications of the graduate scientific and technical staff members (gsm) and with the support staff.

##### Graduate Scientific and Technical Staff

##### Numbers of the Graduate Scientific and Technical Staff (Table 5)

More than 38,000 gsm are engaged in AR activities, representing about 18,000 potential research years (pRys). 99% of the gsm are national. There are only 406 expatriates, 76% of whom are hosted by three countries: Libya (141 expatriates, mostly in the faculties of agricultural sciences), the United Arab Emirates (117 expatriates, who represent around two-thirds of the graduate staff in the three categories of NARS institutions), and Yemen (51 expatriates, relatively numerous in development projects included in the category of "other NARS institutions").

The graduate human resources are unevenly distributed among the countries. Egypt alone possesses 37% of the total gsm and pRys. Iran and Turkey together gather 30% of the gsm and 33% of the pRys of the WANA region. All the other countries count for less than one-third of the scientific potential of the region.

The breakdown of this scientific potential among the three large categories of NARS institutions deserves some comments (see also Section 9.2.1):

- More than 16,000 gsm are working in AR institutes (ARIs) and are equivalent to a little more than 11,000 pRys, which means that the graduate staff members allocate around 70% of their time to AR activities and 30% to other activities (administration, development/extension, education, etc.).
- Less than 17,000 gsm are in faculties of agricultural sciences (FASs) and represent 4,100 pRys, as they are assumed to allocate a normative 25% of their time to AR (see Chapter 3, Methodology).
- At least 5,300 gsm work in the other NARS scientific and technical institutions and devote around 50% of their time to AR. The importance of this category of NARS institutions is most certainly higher, as the related inventory was incomplete in some countries (Ethiopia, Iran, Libya).

##### Qualifications of the National Graduate Scientific and Technical Staff

The qualifications of the NARS gsm is a sensitive issue. For all the NARSs (except Algeria), relatively accurate data is available for the national staff of the ARIs and FASs, which are the two largest categories of NARS institutions (Table 6). Other data concerning expatriate staff (mostly PhD holders) and the other NARS institutions (around 40% PhD holders) is incomplete.

Table 4 - Structure of the WANA NARSs: Tentative Structural Typology of the NARSs

Country/ Sub-Region		Degree of NARS Concentration				Degree of NARS Integration			Typology of the NARS		
		Very high	High	Med- ium	Low	Very low	High	Mod- erate			
Small Countries	Cyprus Lebanon	VH VH					H M		NARS very concentrated and well integrated	1 ARI highly dominant	Coverage of the agroecological regions of the country moderately balanced, except Eritrea (good coverage)
	Eritrea		H				H		NARS concentrated and well integrated	1 ARI and 1 FAS highly dominant	
	Jordan		H				M		NARS concentrated and moderately integrated	1 dominant ARI. Important set potential in FASs marginally involved in AR	
	Libya		H					W			
	Bahrain U.A. Emirates		H					W W	NARS concentrated or rather fragmented and not integrated	Relatively large number of small ARIs and OIs without relations	
Medium-size Countries	Yemen		H					W	NARS concentrated and moderately int-egrated	1 dominant ARI. Larg- scientific potential in FASs marginally involved in AR	Coverag- of the agroecological regions very unbalanced
	Sudan		H								
	Iraq			M			M		NARS rather fragmented and moderately or not integrated	Relatively large number of STIs with limited relations	Good/moderate coverage of the agroecological regions
	Morocco			M				W			
	Syria			M				W			
	Tunisia				L		M		NARS very fragmented and moderately int-egrated	Large number of STIs partially integrated through IRESA	Coverage of the agroecological regions very unbalanced
	Algeria <sup>a</sup>					VL		W	NARS very fragmented and not integrated	Large number of small STIs weakly linked	
Large Countries	Ethiopia	VH					H		NARS very concentrated and well integrated	One ARI highly dominant	Good coverage of the regions
	Egypt		H					MW	NARS concentrated and moderately integrated	Large main complementary ARIs with limited/poor relations. Numerous FASs marginally involved in AR	Regional coverage very unbalanced in Egypt, moderately balanced in Iran and Turkey
	Iran		H					MW			
	Turkey		H					MW			

Source: Degree of NARS concentration: see Table 2. Degree of NARS integration: see Table 3

**Table 5 - The WANA NARSs: Graduate Human Resources (1996–1998)**

ARIs: AR Institutes. FASs: Faculties of Agricultural Sciences. OIs: Other institutions.

*Italics:* Approximate data.

Country/ Sub-Region	Graduate Scientific & Technical Staff (Units)					AR Potential Research Years (pRyS)				
	Total NARS		Breakdown per category of institutions			Total NARS		Breakdown per category of institutions		
	Total	Expatriates (included in total)	ARIs	FASs	OIs	Total	Expatriates (included in total)	ARIs	FASs	OIs
1 Algeria	2110	0	46	720	1344	575	0	41	155	379
2 Libya	622	141	179	404	39 <sup>a</sup>	264	35	131	101	32
3 Morocco	1073	29	453	440	180	606	20	387	111	108
4 Tunisia	797	0	276	362	159	368	0	223	91	54
A North Africa	4602	170	954	1926	1722	1813	55	782	458	573
5 Egypt	14320	0	6380	5900	2040	6710	0	3800	1480	1430
6 Eritrea	115	10	79	36		61	4	47	14	
7 Ethiopia	733	5	475	258	- <sup>a</sup>	475	1	411	64	- <sup>a</sup>
8 Sudan	1331	0	588	680	63	595	0	400	170	25
B Nile Valley/Red Sea	16499	15	7522	6874	2103	7841	5	4658	1728	1455
9 Cyprus	40	0	40			40	0	40		
10 Iraq	2134	0	324	1510	300	770	0	244	376	150
11 Jordan	449	24	201	181	67	198	8	133	49	16
12 Lebanon	165	6	60	89	16	83	3	54	23	6
13 Syria	2290	0	933	1033	324	1058	0	701	203	154
C West Asia	5078	30	1558	2813	707	2149	11	1172	651	326
14 Iran	5623	5	3954	1555	114 <sup>a</sup>	3610	5	3158	389	63 <sup>a</sup>
15 Turkey	5657	0	1746	3360	551	2288	0	1157	840	291
D Highlands	11280	5	5700	4915	665	5898	5	4315	1229	354
16 Bahrain	62	18	30		32	32	11	21		11
17 United Arab Emirates	166	117	94	53	19	73	50	56	13	4
18 Yemen	529	51	320	149	60 <sup>a</sup>	245	25	187	38	20 <sup>a</sup>
E Arabian Peninsula	747	186	444	202	111	350	86	264	51	35
F Total WANA	38216	406	16178	16730	5308	18051	152	11191	4117	2743

a: Ethiopia, Iran, and Yemen: Resources of OIs are most likely underestimated.

**Table 6 - The WANA NARSs: Highest Academic Level of the National Graduate Staff<sup>a</sup> at the Agricultural Research Institutes and Faculties of Agricultural Sciences (1996–1998)**

Country/ Sub-Region	A. AR Institutes (ARIs)			B. Faculties of Agricultural Sciences (FASs)			C. For ARIs: % of PhD and MS Holders out of the Total ARIs + FASs	
	Total N	Including PhD - %N	Including MS - %N	Total N	Including PhD - %N	Including MS - %N	PhD <sup>d</sup>	PhD + MS <sup>d</sup>
1 Algeria <sup>a</sup>	(46)	...	...	(720)	...	...	...	...
2 Libya	179	17 9	46 26	263	167 63	56 22	9	22
3 Morocco	434	65 15	285 66	430	248 58	168 39	21	46
4 Tunisia	276	35 13	173 62	362	128 35	200 56	21	39
<b>A North Africa<sup>b</sup></b>	<b>889</b>	<b>117 13</b>	<b>504 57</b>	<b>1055</b>	<b>543 51</b>	<b>424 41</b>	<b>18</b>	<b>39</b>
5 Egypt	6380	3020 47	540 9	5900	4070 69	750 13	43	42
6 Eritrea	73	0 0	10 14	32	3 10	15 46	0	36
7 Ethiopia	475	64 13	218 46	253	50 20	147 58	56	59
8 Sudan	588	153 26	316 54	680	340 50	200 29	31	46
<b>B Nile Valley/Red Sea</b>	<b>7516</b>	<b>3237 43</b>	<b>1084 14</b>	<b>6865</b>	<b>4463 65</b>	<b>1075 15</b>	<b>42</b>	<b>44</b>
9 Cyprus	40	22 55	18 45	0			100	100
10 Iraq	324	46 14	63 20	1510	493 33	465 30	9	10
11 Jordan	201	27 13	79 40	157	114 73	30 19	19	42
12 Lebanon	59	21 36	23 39	84	49 58	21 25	30	39
13 Syria	933	78 8	97 11	1033	571 55	71 7	12	21
<b>C West Asia</b>	<b>1557</b>	<b>194 12</b>	<b>280 18</b>	<b>2784</b>	<b>1227 44</b>	<b>587 21</b>	<b>14</b>	<b>21</b>
14 Iran	3949	235 6	1431 36	1555	597 38	681 44	28	57
15 Turkey	1746	305 17	479 28	3360	1935 58	1425 42	14	15
<b>D Highlands</b>	<b>5695</b>	<b>540 9</b>	<b>1910 34</b>	<b>4915</b>	<b>2532 52</b>	<b>2106 42</b>	<b>18</b>	<b>35</b>
16 Bahrain	19	2 11	4 21	0			100	100
17 United Arab Emirates	30	2 7	7 23	16	5 31	6 38	18	45
18 Yemen	301	50 17	93 31	137	87 64	23 16	36	57
<b>E Arabian Peninsula</b>	<b>350</b>	<b>54 15</b>	<b>104 30</b>	<b>153</b>	<b>92 60</b>	<b>29 19</b>	<b>37</b>	<b>57</b>
<b>F Total WANA<sup>a</sup></b>	<b>16007</b>	<b>4142 26</b>	<b>3882 24</b>	<b>15772</b>	<b>8857 54</b>	<b>4258 27</b>	<b>32</b>	<b>38</b>

a: Algeria: Data not available. b: Without Algeria. c: PhD column: Number of PhD holders at the ARIs divided by total number of PhD holders at the ARIs and FASs. d: PhD and MS column: Number of PhD and MS holders at the ARIs divided by total number of PhD and MS holders at the ARIs and FASs.

The qualifications of the national gsm is highly variable according to the categories of institutions and the countries:

- At the ARIs, 26, 24, and 50% of the national gsm are PhD, MS, and BS holders<sup>1</sup>, respectively. The ARIs of Cyprus, Egypt, Lebanon, and Sudan have the largest proportion of researchers with PhD (55, 47, 36, and 26%, respectively), while those of Eritrea, Iran, Libya, Syria, and the United Arab Emirates have very few qualified researchers (less than 9% are PhD holders). Few countries (Cyprus, Lebanon, Morocco, Tunisia, and Sudan) have ARIs with 25% or less who are BS holders; Eritrea and Syria have an inverse situation (more than 80% of the staff at the ARIs are BS holders).
- At the FASSs, 54, 27, and 19% of the national gsm are PhD, MS, and BS holders, respectively. In most of the NARSs, the majority of graduate staff at the FASSs are PhD holders. However, in Eritrea, Iraq, and Syria, more than one-third of the gsm at the FASSs are BS holders.
- At the other NARS institutions, the academic level of the gsm seems intermediate between the levels at the ARIs and FASSs<sup>2</sup>, with highly qualified researchers at the “scientific” institutions<sup>3</sup> and relatively low qualified gsm at the “technical” institutions<sup>4</sup>.

This means that for the WANA region and all categories of institutions, according to the breakdown of gsm and pRYs per category of institutions (see Table 5), around 41, 26 and 33% of the national gsm have PhD, MS, and BS degrees; and roughly 35, 25 and 40% of the total pRYs come from PhD, MS and BS holders<sup>5</sup>, respectively. If we consider—as most of the countries do—that research can be implemented efficiently only by the PhD holders and young MS holders preparing PhD degrees under the supervision of the PhD holders<sup>6</sup>, it would be realistic to assume that only about 50% of the 18,000 pRYs of the region are really able to undertake AR activities.

As seen above, the ARIs have few highly qualified staff, particularly when compared with the FASSs; this is confirmed by the fact that the ARIs employ only 32% of the PhD holders and 38% of the PhD and MS holders of the agricultural scientific institutions (ARIs and FASSs) (see Table 6, columns C). In almost all countries, this situation results from the much better career and salary schemes offered in the past—and still often prevailing—to academic staff members, which may reflect the higher priority given to university education than to research, and which still continues to this day. At present:

- the differences in career and salary schemes between the ARIs and FASSs remain large in the majority of countries, both in countries where ARIs are autonomous and their researchers have specific career schemes with small salary advantages (Iran, Iraq, Jordan, Libya, Sudan, Turkey), and in countries where ARIs are not autonomous and their researchers have the same career and salary schemes as gsm or public servants working in administrative directorates or services (Bahrain, Eritrea, Syria, UA Emirates);
- researchers are enjoying similar status and salaries<sup>7</sup> as academic staff members only in autonomous ARIs of a few countries (Egypt, Lebanon, Morocco, Tunisia); Ethiopia is the only country where researchers are receiving slightly better advantages.

<sup>1</sup> These percentages, as well as the following, refer to the highest degree obtained.

<sup>2</sup> Which means that at the OIs, around 41, 26 and 33% of the national gsm are PhD, MS and BS holders, respectively.

<sup>3</sup> Such as the National Research Center in Egypt; the Marmara Research Center in Turkey; the nuclear energy organizations or research institutes in Egypt, Iraq, Iran, Syria, and Turkey; specialized departments or units of faculties of science, technology, engineering, economic sciences, arts, etc. in Jordan, Syria, and Turkey.

<sup>4</sup> Such as sectorial “research-development” institutes or directorates; sectorial or regional development projects (the huge GAP in Turkey; numerous relatively small projects in Yemen); sectorial development directorates, services or projects (remote sensing centers in Lebanon, Libya, and Syria; soil laboratories in Tunisia and Ethiopia; water agencies/directorates in Tunisia; etc.); public agro-industrial enterprises (cotton in Syria, tobacco in Iran and Turkey, etc.).

<sup>5</sup> The latter includes all gsm (national and expatriate, where expatriates represent less than 1% of the total gsm), whereas the former breakdown of staff qualifications is related to national gsm per degree.

<sup>6</sup> It is also highly significant that in most of the FASSs only PhD and MS holders are considered as academic staff and BS holders as “support staff” or technicians.

<sup>7</sup> It is worth to note that improvement of the career and salary schemes of researchers in Morocco and Tunisia is recent (within the last 10 years) and has been decided within the context of the global renovation of the Moroccan

It is also worth to note the large differences between salaries of researchers in the WANA countries and salaries or incomes of other employee groups. Researchers' salaries are generally much lower (around 50%) than the salaries earned by employees with the same academic qualification in the private sector (which globally offer a limited number of jobs). However, as seen in [Table 7](#), related to some countries, senior researchers' salaries are relatively high in their country.

- They are relatively very high in Ethiopia, Eritrea, Morocco, and Tunisia (37, 33, 12, and 8 times the gross domestic product—GDP—per capita, respectively), and should allow the full dedication of researchers to their research activities.
- They are relatively very low in Turkey (1.8) and relatively low in Syria (2.8 times the GDP per capita, despite some recent improvements), where most of the staff (researchers and other staff members) often have to seek other sources of income.
- They are intermediate in other countries (Egypt, Iran, Jordan, Lebanon, Sudan). In Sudan, researchers are receiving the lowest salaries in the entire WANA region, which explains their strong attrition (leaving their positions to join the private sector in the country or for jobs out of the country).

The consideration of these issues of career and salary schemes is essential for recruitment of researchers, stability, and productivity. It is highly significant that in the process of renovation of some ARIs and NARSS, undertaken with the support of the World Bank (Moroccan INRA, Tunisian NARS), improvements in these fields were included among the stipulations dictated by the Bank for gaining its support and obtaining loans. For some countries where the academic level of the gsm at the ARIs is particularly low (0% PhD holders in Eritrea, 6% in Iran, 7% in UA Emirates, 8% in Syria, 9% in Libya, 11% in Bahrain), action is urgently required in that direction.

### Support Staff

[Table 8](#) gives some information about the support staff, including technicians and other categories of human resources with medium and low qualifications ("other support staff," OSS: clerks, laborers, drivers, etc.). It warrants some comments related to the relative numbers, quality, and status of this staff in the two main categories of scientific institutions of the NARSs: the AR institutes and the faculties of agricultural sciences.

[AR Institutes](#), in all countries, suffer a more or less strong imbalance in the numbers of technicians and OSS compared to the general agreed upon standards of 2 technicians and 3–4 OSS per researcher. Situations differ according to country and to the ARIs within each country.

- The Cyprus ARI possesses slightly unfavorable ratios (just under the standards), but its support staff, whose number is only slightly deficient, is certainly much better employed (high level of technology at the research stations).
- In Egypt, the huge ARC enjoys rather well-balanced numbers of support staff, however, they are considered as superfluous as many of the BS holders are acting as technicians; other ARIs are much less endowed.
- In Bahrain, Lebanon, Libya, Morocco, Sudan, Tunisia, and Yemen the main ARIs are in an "intermediate stage," with relatively satisfactory numbers of technicians or OSS; the numbers of technicians are insufficient in Lebanon, Morocco<sup>1</sup>, and Tunisia, and the OSS are too few in Libya and too numerous in Sudan. Other ARIs in Morocco and Sudan have a strong deficit in both.
- In Eritrea, Ethiopia, and Iran (AREEO), ARIs have only 0.6 to 0.7 technicians per researcher.
- In Jordan, Syria, Turkey, and the UA Emirates, ARIs show an acute lack of technicians (0.1–0.2 per researcher) and a deficit in OSS, partly compensated for in Jordan and Syria by the use of BS holders as technicians.

Most of the ARIs also complain about the low quality of their support staff, especially technicians, mainly due to the very low salaries offered in a large majority of countries<sup>2</sup> which discourages good candidates, and to the limited opportunities for upgrading<sup>3</sup> and to budget constraints.

INRA and the Tunisian ARIs, undertaken with the support of the World Bank (the related decisions were among the stipulations dictated by the Bank for providing its loans, and thus considered as an essential step for the targeted renovations). It is surprising that such stipulations were not enforced in Jordan when NCARIT received similar a loan.

<sup>1</sup> At INRA, the largest ARI in Morocco, the actual deficit of technicians is larger because many of them are assigned to administrative positions (clerks, etc.).

<sup>2</sup> At the ARIs, the largest discrepancies in salaries between senior researchers, technicians, and OSS are evident in Egypt (technicians' salaries are 10 times less than those of PhD holders), Ethiopia, Morocco, etc.; while the smallest discrepancies are in Syria and Iran (3 and 3.5 times less, respectively), where unqualified staff is relatively well paid.

<sup>3</sup> However, Jordan ARIs consider that the numbers and skills of technicians and other support staff are insufficient due to the very low salaries offered by the public institutions and to the possibilities for technicians to prepare higher diplomas.



**Table 7 - Salaries at the Agricultural Research Institutions (1996–1998)**

Average salaries per month for researchers with PhD and 10 years of professional experience at the main ARI (salaries plus fringe benefits in some countries)

Country/ Sub-Region	A. Income/Month (US\$)			B. Coefficient for Parity Income (1996)	C. Adjusted Researcher Income/Month (US\$) = a × B
	a. Researcher (1996–1998)	b. GDP per capita per month (1996)	a/b		
Morocco	1300	110	11.8	2.8	3640
Tunisia	1300	168	7.7	2.6	3380
Egypt	440	89	4.9	3.6	1580
Eritrea	500	15	33	5.3	2650
Ethiopia	330	8.9	37	4.3	1420
Sudan	130	24	5.4	3.8	490
Jordan	700	140	5	2.5	1750
Lebanon	2000	360	5.4	1.1	2200
Syria	260	93	2.8	4.8	1250
Iran	500	126	4	2.7	1350
Turkey	450	248	1.8	2.1	950

Source: a. Monographs. b. and B. Chapter 2, Table 1.

**Table 8 - The WANA NARSs: Technicians and Other Support Staff in the Main Scientific Institutions (1996–1998)**

Techn.:gsm = Number of technicians per graduate staff member. OSS:gsm = Other support staff per graduate staff member.  
Algeria and ...: Data not available.

Country/ Sub-Region	A. AR Institutes			B. Faculties of Ag. Sciences			Observations
	Acronym	Techn.: gsm	OSS: gsm	Acronym	Techn.: gsm	OSS: gsm	
1 Libya	ARC ASRC	1.9 1.3	0.7 1.3	FASs <sup>a</sup>	...	...	a. 7 FASs: BS holders acting as technicians; technicians and OSS very few and mobilized in education activities.
2 Morocco	INRA CNRF	1.1 0.7	3.8 ...	IAY ENA-Mek	0.4 0.5	2 ...	
3 Tunisia	IRESA <sup>b</sup> IRA	1.2 0.8	4.7 3	IRESA <sup>c</sup>	0.3	1.8	b. 4 IRESA AR institutes. c. 9 IRESA academic institutions.
4 Egypt	ARC <sup>d</sup> DRC <sup>d</sup>	2.8 0.3	3 1	FASs <sup>e</sup>	...	...	d. Most of the BS holders are acting as technicians. e. 25 FASs: Acute lack of technicians and OSS.
5 Eritrea	DARHRD	0.7	0.15 <sup>f</sup>	CAAS	...	...	f. Only clerks (OSS: part-time employees).
6 Ethiopia	EAEO	0.6	5.7	AUA	...	...	
7 Sudan	ARC ARRC	2 0.1	7.6 0.2	FAUK FASUG	0.2 0.1	...	
8 Cyprus	ARIC	1.7	1.8				No FAS.
9 Iraq	SBAR	1.4 <sup>g</sup>		CA/Bagd.	...	...	g. 1.4 technicians and OSS per gsm.
10 Jordan	NCARTT	0.16 <sup>h</sup>	2.3	FA/Amm.	...	...	h. BS holders acting as technicians.
11 Lebanon	LARI	1	4.7	FASs	...	...	
12 Syria	DASR <sup>i</sup> DIWU <sup>i</sup>	0.16 0.7	1.8 1.5	FASs <sup>j</sup>	0.24	...	i. Many BS holders working as technicians. j. 6 FASs: BS holders considered as support staff.
13 Iran	AREEO MOJC	0.7 0.4	2.3 1.7	FASs <sup>k</sup>	0.15	1.8	k. 24 colleges.
14 Turkey	GDAR GDRS	0.1 3 <sup>o</sup>	2.6	FASs <sup>l</sup>			l. Research assistants (MS holders) acting as SS. m. 3 technicians and OSS per gsm.
15 Bahrain	ARD	1.7	5.7				No FAS.
16 Un. Arab Emir.	ARD	0.18	...	FAS	0.17	...	
17 Yemen	AREA	1.1	2.1	FAUA <sup>n</sup>	...	...	n. Technicians and OSS are scarce.

Another category of support staff deserves some comments: the highly qualified administrative staff. This staff, necessary for good management of the human, material and financial resources, is very scarce in most of the ARIs, which means that the related tasks are generally taken over by the best scientists at the expense of their scientific responsibilities.

At the FASs, the previous imbalances are generally more acute. Technicians and other support staff are very few and are mobilized to assist in teaching activities. The Moroccan FASs (IAV/Rabat and ENA/Meknès) are the least disadvantaged on this issue. In some countries, the support staffs tasks are usually covered by BS holders (Egypt, Jordan, Libya, Sudan, Syria) or even by MS holders (Turkey<sup>1</sup>). Such gaps represent a large waste of qualified human resources and partly explain the actual limited commitment of the FASs in AR.

All these imbalances and deficiencies in support staff constitute a strong limiting factor that constrains the research efficiency of the scientists. However, few ARIs are conscious of such weakness; support staff' career and salary schemes are rarely among their priorities.

### 9.3.2 Overview of the NARS Financial Resources

The total financial resources or expenditures (TE) allocated to AR in the 18 WANA countries amount to around US\$ 412 million (Table 9), consisting of

- US\$ 376 million funded by the countries (91% of TE), comprised of public/budgetary allocations from the government and some self-generated resources (AR contracts funded by national public and private organizations; production, services and/or development activities: seed, plant and vaccine production; soil/water/food analyses, soil studies, socioeconomic studies, etc.);
- US\$ 17 million from loans, mainly provided by the World Bank, taken up by a few countries (Jordan, Morocco, Tunisia, Turkey, Yemen), and
- less than US\$ 19 million granted by national and international donors or agencies.

The financial resources are unevenly distributed among the countries: Iran and Turkey gather 50% of the total financial resources of the WANA region, then comes Egypt (16%) and Morocco (10%); all the other NARSs meet the remaining resources (24%).

A good number of NARSs rely only on national resources (Algeria, Bahrain, Iraq, Iran, Libya, UAE). Foreign grants are significant in Eritrea and Yemen, where they are much higher than the national contributions; while they are relatively significant in Egypt, Ethiopia, and Jordan, and marginal in Cyprus, Lebanon, Morocco, Syria, Tunisia, and Turkey.

Areas of expenditure vary according to country and institution. In most of the NARSs, ARIs allocate a larger part of their financial resources to personnel expenses (salaries and allowances), and a relatively small part to operational and capital costs (OCC). OCC covers the researchers' direct working resources, general expenses of the institution, depreciation of infrastructure and equipment, hiring of seasonal staff, etc. "Relatively" means that OCC is often insufficient and far from covering the research needs, which results in a rather low rate of actual employment of the researchers, this concept will be developed in Section 9.3.3. Also, in most of the NARSs, the FASs are facing a more difficult situation with respect the availability of OCC for research, which explains their low actual involvement in AR activities.

The breakdown of the total financial resources/expenditures among the three large categories of NARS institutions calls for some comments (see also Section 9.2.1). The bulk (78%) of these resources is mobilized by the ARIs, and 15% by the "other institutions" (OIs). Only 7% of the NARS resources belong to the FASs; however, this percentage underestimates the real situation because in many countries, academic staff members are involved in AR activities funded directly by the two other categories of institutions (ARIs and OIs) within the framework of contracts between their faculties and their research partners or through personal relations.

<sup>1</sup> In this country, all the academic staff members are PhD holders, and the remaining staff is mainly made up of research assistants, generally MS holders preparing PhD degrees, who usually act as support/technical staff for the former.

**Table 9 - The WANA NARS: Annual Financial Resources (1996–1998)**  
(US\$ million)

ARIs: AR Institutes. FASs: Faculties of Agricultural Sciences. OIs: Other institutions.  
...: Data not available.

Country/ Sub-Region	National (NE)	% total NE/TE	Loan (LE)	Foreign grants (FE)	Total (TE)	TE: Breakdown per Category of Institutions		
						ARIs	FASs	OIs
1 Algeria <sup>a</sup>	13.7	100			13.7	1.8	2.9	9
2 Libya	13.1	100			13.1	9.6	1.2	2.3
3 Morocco	36.3	90	3	1	40.3	25.2	4.9	10.2
4 Tunisia	12.8	85	1.8	0.4	15	10.8	2.2	2
<b>A North Africa</b>	<b>75.9</b>	<b>92</b>	<b>4.8</b>	<b>1.4</b>	<b>82.1</b>	<b>47.4</b>	<b>11.2</b>	<b>23.5</b>
5 Egypt	60.8	90		6.8	67.6	52.2	4.3	11.1
6 Eritrea	0.4	22		1.4	1.8	1.4	0.4	
7 Ethiopia	6.8	82		1.5	8.3	8	0.3 <sup>b</sup>	.. <sup>b</sup>
8 Sudan	2.9	94		0.2	3.1	2.8	0.2	0.1
<b>B Nile Valley/Red Sea</b>	<b>70.9</b>	<b>88</b>		<b>9.9</b>	<b>80.8</b>	<b>64.4</b>	<b>5.2</b>	<b>11.2</b>
9 Cyprus	5.4	99		0.1	5.5	5.5		
10 Iraq	...	100		...	...	...	...	...
11 Jordan	4.3	75	0.2	1.6	6.1	4.8	1.1	0.2
12 Lebanon	3.3	87		0.5	3.8	3.3	0.4	0.1
13 Syria	13.7	90		1.6	15.3	10.6	0.8	3.9
<b>C West Asia<sup>c</sup></b>	<b>26.7</b>	<b>87</b>	<b>0.2</b>	<b>3.8</b>	<b>30.7</b>	<b>24.2</b>	<b>2.3</b>	<b>4.2</b>
14 Iran	98.7	100		-	98.7	92	5.4	1.3 <sup>b</sup>
15 Turkey	99.6	90	9.9	1.2	110.7	86.5	3.8	20.4
<b>D Highlands</b>	<b>198.3</b>	<b>95</b>	<b>9.9</b>	<b>1.2</b>	<b>209.4</b>	<b>178.5</b>	<b>9.2</b>	<b>21.7</b>
16 Bahrain	3.2	100			3.2	2.3		0.9
17 United Arab Emirates	...	100		...	...	...	...	...
18 Yemen	1.4	23	2.1	2.6	6.1	4.3	1.6	0.2 <sup>b</sup>
<b>E Arabian Peninsula<sup>d</sup></b>	<b>4.6</b>	<b>49</b>	<b>2.1</b>	<b>2.6</b>	<b>9.3</b>	<b>6.6</b>	<b>1.6</b>	<b>1.1</b>
<b>F Total WANA<sup>e</sup></b>	<b>376.4</b>	<b>91</b>	<b>17</b>	<b>18.9</b>	<b>412.3</b>	<b>321.1</b>	<b>29.5</b>	<b>61.7</b>

**a:** Algeria: Approximate data. **b:** Ethiopia, Iran, and Yemen: Resources of OIs are most likely underestimated. **c:** West Asia: Total without Iraq. **d:** Arabian Peninsula: Total without United Arab Emirates (UAE). **e:** WANA: Total without Iraq and the United Arab Emirates.

It is worthwhile to emphasize the complexity of managing the financial resources, which prevails in almost all countries and institutions.

- ARI leaders generally complain about the difficulties faced in that respect: public budgets, officially agreed upon by the governing ministries or bodies, are, at times, far from being actually allocated; actual budgets are unstable over the years; delays in fund liquidation are frequent; fund categories (staff, operation, capital) are too rigid; financial relations with suppliers and with public or private research partners are complicated, etc. These difficulties are particularly acute in those ARIs without administrative and financial autonomy, e.g., the AR institutions directly managed by ministries (department, directorate or division). These institutions sometimes do not have direct responsibility for managing their human, material and financial resources (Bahrain, Eritrea, Syria, UA Emirates).
- Most of the FASSs face an even harder situation: their limited resources are directly managed by their universities according to the available funds, with priorities generally given to education and to staff and student issues and not to research. Frequently, their deans do not have control of their resources and are sometimes unaware of the actual extent of their total or research resources. FASSs of the francophone countries (Algeria, Morocco, Tunisia) are in a much better position as they are autonomous and are not governed by universities.

### 9.3.3 Cross-Country Comparisons of the NARS Human and Financial Resources

International comparisons of NARS resources rely on some ratios relating to human and financial resources. Attention will be given, first to the most significant ratios, and then to other ratios.

#### Most Significant Ratios (Table 10)

##### Actual Employment Rate (AER) of the Scientific Potential

AER represents the ratio of total actual RYs<sup>1</sup> to total potential RYs ( $AER = aRYs + pRYs$ ). Despite its rough, approximate value, it constitutes the most comprehensive yardstick of the degree of “quantitative efficiency” of the NARS.

AER is rather low (36%) for the whole region, with large variations among countries.

- Fig. 1 shows a positive but rather weak correlation between AER and the wealth of the countries (measured by the GDP per capita); the richest countries seem to have more efficient NARSS, but among the more numerous poorer countries, there are very large differences.
- Fig. 2 relates to the size of the countries (measured by their population). It shows two groups of countries: (i) in the group with less than 30 million inhabitants, AER is negatively correlated with population, i.e., NARS efficiency is higher in the small countries than in the medium ones (except Morocco), and (ii) in the largest countries, AER is low (ranging from 25% in Egypt to 48% in Ethiopia).
- AER is satisfactory (more than 70%) in a few countries (Bahrain, Cyprus, Eritrea, Lebanon, Libya, Morocco) which have the following characteristics: their main ARI institutions enjoy good levels of operation and capital budget (OCC) per graduate staff member or pRY, their FASSs are in a relatively favorable financial situation, and their graduate staff members are able to devote to AR activities an actual percentage of their time which is close to the normative 25% used for estimating the pRYs.
- AER is very low (less than 30%) in other countries (Algeria, Egypt, Iran, Iraq, Sudan) which have the opposite characteristics: due to their very limited OCC, their main ARI institutions are far from providing sufficient working resources for their researchers, and their FASSs are generally in a less favorable situation, which means that their graduate staff members are poorly committed to AR activities.
- Other countries (Ethiopia, Jordan, Syria, Tunisia, Turkey, Yemen) are in an intermediate position.

<sup>1</sup> aRY was estimated through different criteria, especially the available amount of OCC per pRY (see Chapter 3, Section 3.3.1).

**Table 10 - The WANA NARS: Most Significant Ratios for Cross-Country Analysis**

F = Actual RYs to potential RYs. I to L = AR expenditures to Agricultural Gross Domestic Product (AGDP)

*Indices: Approximate data. —: Data not available.*

Country/ Sub-Region	Data on Economy <sup>a</sup>			AR Research Years		Ratio nRYs : pRYs (%)	AR Expenditures (E: US\$ million)		Ratio AR Expenditures : AGDP (%)			
	GDP per capita (US\$)	AGDP (US\$ billion)	AGDP + I – E <sup>b</sup> (US\$ bill.)	pRYs	nRYs		National (NE)	Total (TE)	NE/ AGDP	TE/ AGDP	NE/ (AGDP + I – E)	TE/ (AGDP + I – E)
	A	B	C	D	E	I	G	H	I	J	K	L
1 Algeria	1510	5.4	8	575	150	26	13.7	13.7	0.25	0.25	0.17	0.17
2 Libya	4460	2	3.3	264	160	61	13.1	13.1	0.67	0.67	0.40	0.40
3 Morocco	1320	5.3	6.1	606	540	89	36.3	40.3	0.68	0.76	0.60	0.66
4 Tunisia	2010	2.4	2.9	368	200	54	12.8	15	0.53	0.63	0.44	0.52
<b>A North Africa</b>	<b>1730</b>	<b>15.1</b>	<b>20.3</b>	<b>1813</b>	<b>1050</b>	<b>58</b>	<b>78.9</b>	<b>82.1</b>	<b>0.50</b>	<b>0.54</b>	<b>0.37</b>	<b>0.40</b>
5 Egypt	1070	12.1	15.5	6710	1600	24	60.8	67.6	0.50	0.56	0.39	0.44
6 Eritrea	180	0.6	2.8	61	50	82	0.4	1.8	0.67	3.0	0.14	0.64
7 Ethiopia	105	3.4	3.5	475	220	46	6.8	8.3	0.20	0.24	0.19	0.23
8 Sudan	285	3.1	3.1	595	65	11	2.9	3.1	0.09	0.10	0.09	0.10
<b>B Nile Valley/Red Sea</b>	<b>540</b>	<b>19.2</b>	<b>24.9</b>	<b>7841</b>	<b>1935</b>	<b>25</b>	<b>70.9</b>	<b>80.8</b>	<b>0.37</b>	<b>0.42</b>	<b>0.28</b>	<b>0.32</b>
9 Cyprus	12100	1	1.2	40	40	100	3.4	3.5	0.34	0.34	0.43	0.46
10 Iraq	1280	(7.9)	(8.9)	770	225	29	—	—	—	—	—	—
11 Jordan	1640	0.6	1.1	198	125	63	4.3	6.1	0.72	1.0	0.39	0.55
12 Lebanon	4360	1.6	2.7	83	60	72	3.2	3.7	0.20	0.23	0.12	0.14
13 Syria	1120	4.9	4.9	1058	500	47	13.7	15.3	0.28	0.31	0.28	0.31
<b>C West Asia</b>	<b>1670</b>	<b>8.1</b>	<b>9.9</b>	<b>2149</b>	<b>950</b>	<b>44</b>	<b>26.7</b>	<b>30.7</b>	<b>0.33</b>	<b>0.38</b>	<b>0.27</b>	<b>0.31</b>
14 Iran	1520	20	22	3610	1100	30	98.7	98.7	0.49	0.49	0.45	0.45
15 Turkey	2980	28	28	2288	1280	36	99.6	110.7	0.36	0.40	0.36	0.40
<b>D Highlands</b>	<b>2250</b>	<b>48</b>	<b>50</b>	<b>5898</b>	<b>2380</b>	<b>40</b>	<b>198.3</b>	<b>209.4</b>	<b>0.41</b>	<b>0.44</b>	<b>0.40</b>	<b>0.42</b>
16 Bahrain	7890	0.05	0.35	32	24	75	3.2	3.2	6.4	6.4	0.91	0.91
17 United Arab Emirates	16100	(0.7)	(2.4)	73	—	—	—	—	—	—	—	—
18 Yemen	340	0.9	1.6	245	105	43	1.4	6.1	0.18	0.76	0.09	0.38
<b>E Arabian Peninsula</b>	<b>5650</b>	<b>1</b>	<b>2</b>	<b>350</b>	<b>129</b>	<b>47</b>	<b>4.6</b>	<b>9.3</b>	<b>4.8</b>	<b>0.98</b>	<b>2.4</b>	<b>0.48</b>
<b>F Total WANA</b>	<b>1840</b>	<b>91.4</b>	<b>107.1</b>	<b>18051</b>	<b>6444</b>	<b>36</b>	<b>376.4</b>	<b>412.3</b>	<b>0.41</b>	<b>0.45</b>	<b>0.35</b>	<b>0.38</b>

a Source: Table 2, chapter 2 b AGDP + Ag imports – Ag exports see text, section 3.3 c Without Iraq d Without United Arab Emirates e Without the two previous countries

See Figs 1 to 3b in annex

These different values of AER may reflect the role of public institutions in the national socioeconomic policies in each country. In the first category of countries (satisfactory AER), it seems that ARIs and FASs are mainly considered as important tools for development and receive appropriate attention: balanced budget allocations for staff expenses and OCC in both categories of institutions and low ratios of students to academic staff member, which are adapted to realistic conditions for employment, preserving the quality of education and allowing academic staff to implement research. In the second category of countries (very low AER), ARIs (like other public institutions) may be considered mainly as institutions securing jobs for qualified staff regardless of their efficiency, and FASs (and universities in general) have to provide education to as large a number of students as possible, often at the expense of education quality, for alleviating the sociopolitical pressure of young generations facing the difficult problem of underemployment.

Average values of AER for each of the five sub-regions (North Africa, Nile Valley and Red Sea, West Asia, Highlands, and Arabian Peninsula) have no meaning as AER is highly variable among the country members of these sub-regions.

### Ratio of AR Expenditures to Agricultural Gross Domestic Product

This ratio, which compares national (NE) and total expenditures (TE) allocated to AR to the agricultural gross domestic product (AGDP), is by far the most used criterion for cross-country comparisons.

Average NE/AGDP and TE/AGDP for the entire WANA region were estimated at 0.41 and 0.45%, respectively, with large variations among countries. These ratios are much under the 1% (sometimes, even 2%) recommended for developing countries by some international organizations (World Bank, European Union, IFPRI, etc.<sup>1</sup>), which suggests that the investments in AR are largely insufficient. However, these recommended ratios are questionable.

- First, these ratios were proposed largely on the basis of a comparison with the ratio of 2% or more prevailing in developed countries<sup>2</sup>, without taking into account the main structural differences between countries (CIEAM/Casas, 1988; FAO/Casas, 1998).
  - In developed countries, AR expenditures are the sum of public and private financial resources, and are largely allocated to food technology<sup>3</sup>, whereas private contributions and allocations to food technology are very low or nonexistent in most of the developing countries. Thus, for wealthier countries, AR expenditures should be related not to the AGDP but to the sum of the agricultural and agricultural/food industry GDP, which, in the most-developed countries, is twice the AGDP<sup>4</sup>.
  - In the poorest developing countries, it is essential to take into account the low capacity of public funding due to the importance of food consumption at the farm level ("autoconsumption") (certainly higher than 50% of the AGDP in Eritrea, Ethiopia, Sudan, and Yemen) and the very limited possibilities for tax recovery on the AGDP.
- Second, the recommended ratios do not take into account the size and diversity of the agricultural sectors in developing countries. Obviously, research needs are relatively higher in small countries than in large countries which can benefit from the economies of scale on the research costs. They are also higher in countries with a diversified agricultural sector than in countries with very few main commodities (as is generally the case in the poorer countries where four or five commodities often account for more than 80% of the AGDP), and higher in countries with more complex ecological conditions where preservation of natural resources is a main issue.

These observations lead to the conclusion that a ratio of 1% is undoubtedly too high for the WANA countries with middle and low incomes per capita.

NE/AGDP and TE/AGDP range from less than 0.1% (Sudan) to 6.4% (Bahrain), which illustrates the large differences in the attention given to AR in the different countries. Statistical analyses show that there is no clear relation between the values of these ratios and the wealth of the countries (GDP per capita) (see Figs 3a and 3b related to NE/AGDP). There is also no correlation between these values and the size/population of the countries (figures not presented).

<sup>1</sup> For example, IFPRI proposes that "all developing countries should invest at least 1% of the value of their agricultural production in AR, and move towards 2% within the next 5 to 10 years" (IFPRI, October 1995, p. 6).

<sup>2</sup> Slightly less than 2% for middle-income developing countries and above 2% for high-income countries (IFPRI, 1995).

<sup>3</sup> In general, the proportions of private contributions and of research allocated to food technology are higher in richer countries.

<sup>4</sup> For example, in France, in 1985, the ratios of public TE/AGDP and public TE/(AGDP + AFGDP)—with AFGDP as the Agro-food Gross Domestic Product—were estimated at 3.1 and 1.5%, respectively (Casas, 1988).

As most of the WANA countries are net agro-food importers, the same exercises were applied to the national agricultural gross domestic “product and consumption” (AGDPC), equivalent to:  $AGDP + (Ag. imports - Ag. exports)$ , which reflects the actual importance of this sector in a country<sup>1</sup>. In this case, there was also no clear relation between NE/AGDPC or TE/AGDPC and the wealth or size of the country (figures not presented).

Finally, the relative financial efforts dedicated to AR seem to be very specific to every country, regardless of its wealth or size, which is unexpected since most of the similar previous studies revealed a strong positive correlation between AR expenditures and wealth of a country, on the one hand, and a negative correlation between expenditures and size, on the other.

A few countries are in line with these general correlations found in other regions or worldwide. Bahrain, one of the smaller and richer countries, is devoting the highest relative efforts to AR; while Ethiopia, Sudan, and Yemen, which are among the poorest countries, are in an opposite position.

The other countries do not portray “logical” differences (with regard to their wealth or size), for example:

- Lebanon, a rather small country with relatively high per capita income (US\$ 4,360), is among the lagging countries in terms of attention devoted to AR, while Eritrea, having the same size but a very low per capita income (US\$ 180), gives high priority to AR and receives large external assistance.
- Among the countries with medium per capita income and medium size, the NARS of Morocco is enjoying a rather favorable situation ( $NE/AGDP = 0.68\%$ ,  $TE/AGDP = 0.76\%$ ), which is not the case of Algeria ( $NE/AGDP$  and  $TE/AGDP = 0.25\%$ ) and Syria ( $NE/AGDP = 0.28\%$ ,  $TE/AGDP = 0.31\%$ ).
- Egypt, Iran, and Turkey, with about the same large populations, are dedicating AR efforts in a slightly inverse relation to their wealth, Egypt being the country with the smallest per capita income of the three countries and the most extensive national and external efforts.

#### Other Ratios (see Table 11)

Some of the other ratios involve the agricultural labor force (ALF).

- $aRYs/ALF$  and  $pRYs/ALF$  demonstrate a positive correlation with the wealth of the countries<sup>2</sup> (see Figs 4 and 5) such as that for the Mediterranean countries in 1987 (Casas/CIHEAM/1988). This would mean that richer countries are able to mobilize more RYs in relation to their ALF, and would be consistent with the fact that in the richer or more developed countries of the WANA region, ALF is relatively smaller and more productive than in poorer or less developed countries. These ratios are not related with the size of the countries (figures not presented).
- NE per million agricultural laborers ( $NE/ALF$ ) are highly correlated to the wealth of the countries, which indicates that richer countries are allocating more efforts in terms of their agricultural population (see Fig. 6). This is consistent with the fact that ALF is considerably lower in richer countries, which means that the same AR expenditures will benefit a relatively smaller agricultural labor force. Such high correlation exists between  $TE/ALF$  and GDP per capita (figure not presented).
- $NE/ALF$  (as well as  $TE/ALF$ ) seems to decrease with the population of a country, which would mean that the smaller the country, the higher its  $NE/ALF$  and  $TE/ALF$  ratios (see Fig. 7). This seems coherent because in the WANA region, the smaller countries are among the richer ones. However, statistical correlations are not highly significant.

The two ratios,  $pRYs/AGDP$  and  $aRYs/AGDP$ , do not demonstrate, globally, a clear relationship with the wealth and size of the countries (figures not presented).

**As a conclusion to this section**, it seems that most of the NARSs have specific profiles regarding their human and financial resources, conditioned by the history, culture, and sociopolitical environment of their countries and institutions.

<sup>1</sup> For the few WANA countries which are net agro-food exporters (Sudan, Syria, Turkey), AGDPC is equal to AGDP.

<sup>2</sup> This correlation is even stronger if we exclude the two richest countries: Bahrain and Cyprus (no data related to the aRYs).



**Table 11 - The WANA NARS: Other Ratios for Cross-Country Analysis**

ALF: Agricultural labor force. *Italics*: Approximate data. .... Data not available.

Country/ Sub-Region	RYs/ALF (Units/million laborers)		E/ALF US\$ per ag. laborer		RYs/AGDP Units/US\$ million	
	pRYs/ALF	aRYs/ALF	NE/ALF	TE/ALF	pRYs/AGDP	aRYs/AGDP
1 Algeria	250	65	6	6	106	28
2 Libya	2200	1330	109	109	132	80
3 Morocco	144	129	8.6	9.6	114	101
4 Tunisia	409	222	14	17	153	83
<b>A North Africa</b>	<b>242</b>	<b>140</b>	<b>10</b>	<b>11</b>	<b>120</b>	<b>70</b>
5 Egypt	790	132	7.2	8	555	132
6 Eritrea	47	38	0.3	1.4	508	416
7 Ethiopia	21	10	0.3	0.4	134	65
8 Sudan	86	9	0.4	0.4	192	21
<b>B Nile Valley/Red Sea</b>	<b>203</b>	<b>50</b>	<b>1.8</b>	<b>2.1</b>	<b>451</b>	<b>104</b>
9 Cyprus	1000	1000	135	138	40	40
10 Iraq	1100	321	...	...	97	28
11 Jordan	1237	781	29	38	330	208
12 Lebanon	1660	1200	64	74	52	38
13 Syria	790	373	10	11	216	102
<b>C West Asia</b>	<b>1343</b>	<b>593</b>	<b>17<sup>a</sup></b>	<b>19<sup>a</sup></b>	<b>143</b>	<b>63</b>
14 Iran	840	256	23	23	181	55
15 Turkey	197	110	8.3	9.5	82	46
<b>D Highlands</b>	<b>371</b>	<b>150</b>	<b>12</b>	<b>13</b>	<b>123</b>	<b>50</b>
16 Bahrain	3200	2400	320	320	640	480
17 United Arab Emirates	1042	...	...	...	104	...
18 Yemen	144	62	0.8	3.6	272	117
<b>E Arabian Peninsula</b>	<b>206</b>	<b>75<sup>b</sup></b>	<b>2.7<sup>b</sup></b>	<b>5.5<sup>b</sup></b>	<b>206</b>	<b>292<sup>b</sup></b>
<b>F Total WANA</b>	<b>277</b>	<b>99<sup>c</sup></b>	<b>5.8<sup>c</sup></b>	<b>6.3<sup>c</sup></b>	<b>184</b>	<b>66<sup>c</sup></b>

a: Without Iraq. b: Without the United Arab Emirates. c: Without the two previous countries.

See Figs 4 to 7 in annex.

### 9.3.4 The NARS Physical Resources

The NARS physical resources are highly variable according to their nature (infrastructure, equipment, etc.) as well as to the country and institutions. However, it is possible to point out some common features and to outline some national characteristics.

With respect to infrastructures (buildings, stations, farms), they are excessively numerous in many NARSs, including:

- the highly fragmented NARSs (composed of a relatively large number of institutions: see Section 9.2.2), each institution having its own set of facilities regardless of the others; this situation prevails in Algeria, Iraq, Tunisia, and the United Arab Emirates, and to a relatively lesser extent in Morocco<sup>1</sup> and Syria;
- NARSs with “multi-organizational ARIs” which govern a large number of semi-autonomous institutes but, often, still maintaining separate facilities, also NARSs with a large number of FASs: this is the case of Egypt, Iran, and Turkey.

In countries with the above both sets of NARSs, as mentioned in the monograph on the Turkish NARS, the facilities considerable are both in number and size, and possess a huge set of separate units and infrastructures<sup>2</sup>, the management and maintenance of which are very costly. An obvious solution would be to rationalize and reduce these facilities by gathering most of them in a small number of “campuses” (at least one per large region) that would accommodate the essential human and physical resources. This should allow providing common infrastructures and services (conference halls, library, communication facilities, purchase offices, etc.) at a much lower cost and should offer more opportunities for interaction and collaboration among scientists. The physical separation of ARIs and FASs, which generally prevails in the WANA NARSs<sup>3</sup>, partly explains their very limited scientific collaboration.

Infrastructures are also often unevenly distributed throughout a country; in many cases, the best-endowed stations, laboratories, and farms are located in and around the headquarters, the capital, and the most favorable agroecological zones. This is true not only in the NARSs with a low “degree of regional integration” (Algeria, Sudan, Tunisia, Yemen) (see Section 9.2.3), but also in NARSs with “moderate regional integration” which had recently improved their facilities (renovation of existing facilities or establishment of new ones) such as Egypt, Iran, Jordan, and Morocco.

Equipment (scientific and farm equipment, computers, transportation/communication facilities) is often insufficient in quality and quantity and needs to be renovated or reinforced. Shortages of spare parts seem frequent, as a consequence of the lack of standardization or due to difficulties in purchasing in foreign currencies. Few ARIs enjoy good conditions (at least in their main stations and laboratories), especially those which have recently benefited from large national investments (Iran) or external support (Egypt, Jordan, Morocco, Tunisia, Turkey).

Central libraries in the main ARIs are rather satisfactory at least in terms of facilities (buildings), but wide variations among the different libraries are observed in their content, equipment, and operation (particularly services to remote stations). The Egyptian ARC has a very modern library with the most up-to-date computerized information storage and retrieval systems, electronic network, up-dated collections of books, periodicals and journals, etc.<sup>4</sup> INRA/Morocco, INRAT/Tunisia, NCARTT/Jordan, ARD/UAE are all well endowed. However, the situation seems much less favorable in Algeria, Sudan, and Syria as well as in most of the FASs.

All physical resources (infrastructures, equipment, libraries) have suffered large degradation in the internationally isolated countries (Algeria, Iraq, Libya, Sudan).

<sup>1</sup> Where INRA drastically reduced the number and size of its experimental stations some years ago.

<sup>2</sup> For the entire Turkish NARS, farms total more than 40,000 ha, while for Morocco it is 7,000 ha (despite the recent strong reduction which took place within INRA), 5,500 ha in Tunisia, and 6,600 ha solely for the farms of the STIs affiliated to the Ministry of Agriculture in Algeria.

<sup>3</sup> It seems that in the entire region, there is only one example of a campus associating ARIs and FASs; in Meknès/Morocco, the INRA regional center is located in the National Agricultural School, ENA.

<sup>4</sup> The Egyptian National Agricultural Library, ENAL, was established in 1995 in Giza, with the support of a very large USAID grant (cost: US\$ 6.3 million); it serves ARC, all MALR units, the universities, and all individuals involved in agriculture.

## 9.4 RESEARCH ACTIVITIES AND RELATIONS WITH DEVELOPMENT

### 9.4.1 Research Activities

This section deals with research management processes (planning/programming, monitoring/evaluation), research programs (content, deficiencies, trends, scientific dissemination), and international scientific linkages.

#### Research Management Processes

**Research Planning and Programming** - Few countries have prepared formal AR national long- and/or medium-term plans (LTP and MTP, respectively) for their entire NARS, including priority-setting exercises and allocation of resources by research domains or programs<sup>1</sup>. These are: Tunisia (LTP, 1984), Iraq and Jordan (both countries prepared a national strategy for AR and technology transfer, respectively in 1995 and 1996), Lebanon (national AR strategy, 1996), Eritrea (AR MTP 1997–2002), and Yemen (national AR strategy has been recently prepared).

In most of the other countries<sup>2</sup>, AR national plans have been included as components of national economic development plans. They cannot be really considered as AR plans as they generally consist of brief presentations (a few pages) of the most sensitive governmental policy priorities related to the involvement of the NARS institutions, the main priorities in the research programs (sectors, themes, regions), national commitments for resources allocation (often mainly in terms of investment), etc.

Among these other countries, the largest national ARIs have promoted a more or less integrated way of planning/programming in order to guide strategic decisions (relating to research programs and resource allocation) and help establish better equilibrium among the research programs.

- ARC/Egypt<sup>3</sup> and both GDAR and GDRS/Turkey<sup>4</sup> have designed their own “master plan” (medium-term plan applied to one institution).
- INRA/Morocco has developed in the last 10 years a programming system based on consultations between INRA researchers, farmers, and extension agents, and assessment of market demand.
- ARC/Libya and ARC/Sudan have developed priority-setting exercises, based on the analysis of the challenges facing agricultural production in the country (economic importance of the commodity branches, food security, etc.), scientific experience, and information.

**Monitoring and Evaluation** - These processes include the follow-up and assessment of the research programs (adaptation to the plans or programs of the NARS or NARS institutions, scientific consistency, scientific results: content, publication). Information related with these issues is rather fragmented and uneven according to the countries.

It seems that most of the largest and/or experienced ARIs have set up specific bodies for monitoring and evaluating their research programs; sometimes the researchers’ scientific activities as well. These bodies are mainly scientific councils or committees attached to ARI directorates or boards of trustees and to large research programs or

<sup>1</sup> These plans were prepared directly under the responsibility of the Government, represented by the Ministry of Agriculture (Eritrea, Tunisia), or of the largest national ARI (Jordan, Lebanon, Yemen), by scientists from the main NARS institutions. None of these plans, except the Tunisian one, have included resource allocation by region (which is a major issue for NARSs characterized by an unbalanced regional breakdown of their human and physical resources), nor have they been designed with significant participation of farmers’ representatives.

<sup>2</sup> All except Bahrain and UAE (no mention of national economic plan). Iran intends to prepare a national AR strategic plan in the near future. As for Ethiopia, in the early 1990s, efforts to formulate and implement a national AR policy were not sustainable, largely due to the lack of sufficient political commitment and the necessary resources. These efforts have been re-initiated with the creation of the National AR Council, operating under the auspices of the Ethiopian Science and Technology Commission (the recent establishment of EARO, officially mandated to coordinate and guide the national AR policy, may change this situation).

<sup>3</sup> At ARC/Egypt (62% of the total financial resources of the NARS), the latest master plan is the fourth five-year (1997/98–2001/02) research/extension/training program, which is guided by the strategy for agricultural development, in line with what has been accomplished during the previous research plans. This plan, as the previous, has been prepared and is implemented closely with the other national institutions and scientists associated with the ARC programs.

<sup>4</sup> The master plans of GDAR and GDRS (55 and 17% of the NARS total financial resources, respectively) established formal priority-setting mechanisms for the research agendas and set up systematic national, multidisciplinary, multi-institutional research programs for all research activities and topics; they were prepared within the implementation of the Turkish AR Project (TARP, designed in 1990 with the support of the World Bank).

departments, which generally include representatives of other NARS institutions. Some ARIs and countries deserve a few comments.

- In INRA/Morocco, the sectorial committees (cereals, citrus, etc.) include representatives of professional agricultural and agro-food organizations.
- In Tunisia, research committees have been set up at the level of the Ministry of Agriculture (through IRESA), gathering scientists from the NARS institutions concerned as well as agronomists from development agencies.
- In Egypt, four Regional Research and Extension Councils, established in 1992 to promote coordination and cooperation between scientists, researchers, extensionists, technologists, decision-makers, and farmers on a regional basis, are responsible (among their other mandates) for monitoring and evaluating the achievements in research and extension programs in their zone.
- IAR, the largest Ethiopian ARI (now replaced by EARO) used to organize a National Research Review Meeting that included its research leaders and scientists from other NARS institutions. This meeting was held annually to review and approve research projects, particularly those of the IAR centers, as the universities or regional centers were not legally bound by decisions passed in the review system.

Few FASs (Eritrea, Turkey) have started to establish research priority areas.

The research management processes presented above may be considered more or less efficient. However, as will be seen in the following section on research programs, the many national AR plans and master plans have been only partly implemented or sometimes forgotten<sup>1</sup>, programming and priority-setting have often induced limited changes in research programs and resource allocation, and monitoring/assessment bodies have not been always operational.

### Research Programs

Information related with the characteristics of the research programs and their scientific dissemination is also rather fragmented and uneven in some NARSs. However, some of the most common characteristics are listed below.

- Small NARSs and the Algerian NARS (as a medium-size, very fragmented, and weakly integrated NARS) face difficulties in organizing programs endowed with the essential resources (especially qualified human resources) required for achieving significant results.
- In these countries, as well in most of the FASs of the WANA region, research programs are mainly conducted on an individual basis (either by experienced scientists or young scientists preparing PhD degrees).
- In the medium and large NARSs (except Ethiopia), overlapping of research programs is frequent (more frequent in the highly fragmented and moderately or weakly integrated NARSs: Algeria, Egypt, Iran, Iraq, Morocco, Syria, Tunisia, Turkey).

In many monographs, some characteristics are also mentioned for the main ARIs.

- Priority is given to applied and adaptive research. Only a few NARSs (mainly Egypt, Turkey, and, to a lesser extent, Morocco) are currently involved in modern sciences with wide use of biotechnology, isotopes, remote sensing, expert systems, and computers.
- Frequently, there is secondary emphasis on forestry, animal production, food technology, economy, and farming systems. Research programs on crops and natural resources are generally the most established and better covered<sup>2</sup>.

The lack or weakness of permanent research teams on farming systems deserves further comments, given their importance for agricultural development. "Integrated multidisciplinary research on farming systems at the national level is essential for promoting more intensified and sustainable farming systems. Rather than AR and development efforts being directed towards the issue of productivity and how to increase it, the emphasis should be shifted towards ensuring the sustainability of production and the implications of agricultural intensification on the natural-resource

<sup>1</sup> The national AR strategy is being followed by NCARTT/Jordan, but does not serve as an active reference for the FASs and the other NARS institutions.

<sup>2</sup> In Yemen, unbalanced resource allocation between research fields and regions in the main ARI (AREA) is partly compensated for by AR activities conducted by the temporary agricultural projects/programs.

base (soil and water) and the environment, in general" (Egypt monograph)<sup>1</sup>. Significant efforts in that direction have been made in some countries (Entrea, Jordan, Morocco, Tunisia) and initiated in others (Algeria, Egypt, Iraq, Sudan, Syria, Turkey). However, in countries with ARIs covering crops, animal production, and natural resources separately (mainly Algeria, Iran, Libya, Sudan), implementation of the farming systems research approach remains difficult<sup>2</sup>.

Dissemination of research output is through diverse channels: publications (scientific papers, journals, books, bulletins), organization of and participation in seminars and workshops, etc. The situation of publications in the different NARSs is very diverse (limited precise data is available on this issue). The small countries rarely have specialized AR scientific journals, and even if they existed, such publications have been sometimes discontinued (Lebanon). Among the medium-size countries, Morocco seems to have a very active publishing policy: each large NARS institution (INRA, INRH, IAV) has its own publications (total of four scientific journals, many technical bulletins, newsletters, magazines). Although a very large number of MS and PhD theses have been prepared at the FASs, only IAV/Morocco seems to be concerned with supporting the publication of this knowledge. Some of the large countries have a large number of specialized AR scientific journals; in Egypt, several FASs produce periodic journals, open for publication to all AR scientists, and ARC produces its own quarterly journal.

From the monographs, it is difficult to form a reasonable judgment of the scientific productivity (quantity and quality) of the NARSs. The low rates of actual employment of the human scientific potential and the insufficient weight given to scientific achievements in terms of their influence on the researchers' careers in many countries suggest that this scientific productivity is, in general, rather modest if we take into consideration the large number of agricultural scientists in the WANA region.

### Regional and International Scientific Linkages

Scientific collaboration with national scientific institutions of developed countries as well as with international and regional scientific/technical organizations (international AR centers, particularly ICARDA; FAO; CIHEAM; ACSAD; AOAD, etc.) is very variable according to the countries and their institutions.

On the whole, it is active and diversified (the main NARS institutions have relations with both national and international partners) in Egypt, Entrea, Jordan, and Yemen, which are countries that benefit from rather large external financial support (grants and loans). It is also rather well developed in Ethiopia and Morocco.

However, international scientific linkages remain moderate or limited in Tunisia, Lebanon, Syria (mainly with ICARDA and ACSAD, which have their headquarters in the country), Turkey (relations are well developed for GDAR, but rather limited for the other institutions), Bahrain, and UAE; and deficient in Algeria, Iran, Libya, and Sudan. In these countries, which are relatively isolated for political reasons, international AR centers (particularly ICARDA) are basically the only windows to the international scientific community.

For all countries, it is worth to stress on: (i) the rather limited scientific cooperation between the WANA NARSs, which takes place essentially through networks organized by international and regional organizations, particularly ICARDA, CIHEAM, FAO, the Arab Center for Studies of the Arid Zones and Dry Lands (ACSAD) and the Arab Organization for Agricultural Development (AOAD), and (ii) the positive role of international financial agencies (Arab Fund for Economic and Social Development, IFAD, Islamic Bank of Development, the World Bank) and countries (European Union, France, Germany, the Netherlands) in the development of international linkages (North/South as well as South/South).

## 9.4.2 Relations with Development

### Relationships between NARS Institutions and Development Organizations

Channels for these relations are relatively numerous and diversified, but vary from country to another. They exist mainly in the AR institutes and may include:

<sup>1</sup> See Chapter 2, Sections 2.3.2 and 2.4, related to, respectively, the very limited natural resources (land and water) available in the WANA region, and the strategic importance of farming systems research for developing intensified and sustainable production.

<sup>2</sup> ICARDA is playing an active role in setting up or reinforcing research teams on farming systems in the WANA region through the Nile Valley and Red Sea Regional Program (NVRSRP: Egypt, Entrea, Ethiopia, Sudan, Yemen) and the Mashreq/Maghreb project (which involves the four North-African countries and four countries of West Asia: Iraq, Jordan, Lebanon, Syria). It is worth to mention that these projects have provided opportunities to develop not only regional collaboration but also national linkages between NARS institutions which sometimes ignored each other in the past.

- Participation of representatives of public and private development organizations in the management and research committees or special units set up by the NARSs and its institutions (planning/programming committees, scientific councils, research–development councils at national and regional levels, etc.), which may allow better research prioritization according to users' needs (farmers, public and private agro-industrial companies).
- Specific research contracts with public and private development organizations.
- Services (soil/water/feed/animal disease analysis, etc.), soil mapping, direct technical assistance, and utilization of libraries and databases.
- Demonstration experiments in farmers' fields set up and evaluated jointly with extension agents and farmers.
- Field days in experimental stations; workshops, and training courses.
- Preparation of information packages for extension services and farmers (extension leaflets, information on technologies in mass media), etc.

These channels seem rather well organized in:

- Morocco, where INRA and IAV have developed perhaps the most diversified channels, including rather large involvement of the public and private development organizations (some of them directly created at their initiative);
- Egypt, where the Ministry of Agriculture and Land Reclamation has designated ARC as technically responsible (through the ARC Directorate for Extension) for its extension activities supervised by the Central Administration for Agricultural Extension; and where ARC oversees the Regional Research and Extension Councils<sup>1</sup> and national campaigns for commodities<sup>2</sup>;
- Jordan, where relationships of NCARTT with development agencies, extension services, and farmers are, in general, well established, primarily through the MOA Directorate of Agricultural Extension and Information;
- Syria, where the main ARIs are directorates of the Ministry of Agriculture which have comfortable relations with the other directorates in charge of extension/development at national and regional levels; and
- Iran, where extension activities are actually incorporated within the same main NARS institutions.

Linkages between NARS institutions and development organizations have largely improved over the last years in other countries, such as:

- Tunisia, where the recently established “regional development poles” (one per large agroecological zone) offer a good framework for bringing together all the partners concerned with agricultural research and development, including development agencies and farmers' representatives;
- Iraq, where linkages of the NARS institutions with extension/development organizations and with farmers have improved with the recent implementation of the national strategy for agricultural research and transfer of technology;
- Lebanon, where dissemination of research findings to farmers is direct in some areas (cereals, grain legumes, plant nutrition, pest management, etc.) and often takes place through public and private organizations, and local, national and international NGOs (which are playing an increasing role in this process);
- Turkey, where GDAR has recently created a Research–Extension Liaison Department in most of its ARIs and proposed increased support and incentives for scientists to undertake collaborative research with development organizations; and
- Yemen, where the process of research decentralization and the higher attention given to farming systems research within AREA are promising for the future.

<sup>1</sup> These Regional Research and Extension Councils are responsible for discussing problems of agricultural production in the zone and suggesting solutions; discussing and approving research and extension programs in the zone; suggesting methods for finding and supporting research and extension programs in the zone; and monitoring and evaluating the achievements in research and extension programs in the zone.

<sup>2</sup> The national campaigns for commodities were set up for improving the production of cereals (maize, rice and wheat), oil crops, sugar crops, citrus, and banana; in these campaigns, experts and scientists from research centers, universities, and implementing agencies work together in order to guide producers to the use of technology packages developed by researchers.

In some countries, regional and international agriculture centers/organizations play a catalytic role in linking research and extension.

In most of the FASSs of the WANA region, there is no formal institutional relationship with extension services or farmers and no mechanism for technology transfer; thus, relations with development/extension organizations are very limited and are manifested mainly in contacts made essentially on an individual basis according to the research outputs available. The Moroccan and Egyptian FASSs are exceptions as they have developed their own relationships (Morocco) or have integrated linkage organizations where an ARI assumes the leadership role (Egypt).

In any case, whatever their degree of organization, and even for the countries with the best organized linkages, the actual efficiency of relationships between research and development depends on other objective factors related to the NARS features (structure; human, physical and financial resources; etc.) and to the national development/extension organizations. Actual linkages can only be globally weak in countries where NARS and/or development/extension organizations have acute weaknesses, i.e.:

- where NARSs (essentially their main ARIs), with a large extent of variation in their capacities, qualifications, and coordination:
  - are highly fragmented and have a moderate or low degree of integration (Algeria, Libya, Sudan);
  - have researchers with inadequate qualifications and, consequently, with insufficient scientific productivity (Algeria, Bahrain, Eritrea, Iran, Iraq, Libya, Syria, UAE);
  - suffer strong unbalanced regional allocation of resources, leaving large parts of the country without the permanent presence of significant human and physical resources (Algeria, Egypt, Sudan, Tunisia, Yemen); and
  - mobilize very limited financial resources, especially operation and capital budgets (Algeria, Ethiopia, Sudan, Yemen).
- where development/extension organizations are unfavorably structured at national and regional levels (mainly composed of highly centralized public organizations, with lack of well-organized professional and private organizations, such as cooperatives, unions, and sectorial organizations), and have very limited qualified human resources and very low financial resources. A few monographs contain explicit reference on these issues, as shown below:
  - In Morocco and Tunisia, development/extension organizations seem relatively dynamic and diversified (strong agricultural unions at least in some areas).
  - In Egypt, relations with development are hampered by many factors, such as inadequate extension policies, insufficient coordination in MALR directorates and between the ministries concerned, overstaffing and few numbers of staff with high qualifications (especially at the middle level), poor physical facilities in the extension services, etc.
  - In Sudan, “weakness of the extension services (with poor human, physical, and financial resources) and farmers’ organizations is a strong limiting factor for technology dissemination.”
  - In Jordan, the MOA Directorate of Agricultural Extension and Information has recently developed a National Strategy for Agricultural Extension (such initiative has not been mentioned in any other monograph).
  - In Iran, NARS “should provide adequate incentives to the private sector and NGOs for their active investments and participation in the NARS.”
  - In Turkey, “farmers’ unions and cooperatives are government-controlled and operated.”

Moreover, the actual efficiency of relationships between research and development rely mainly on the features of the farmer/grower communities themselves. Advances in agriculture are generally few and slow in countries where the majority of peasants are illiterate and their physical environments receive little attention (poor communication facilities), and where credit/financial and commercial needs are not satisfied.

Finally, in all the countries of the WANA region, relationships between research and development are hampered, to a large extent, by the above constraints, which may explain the following comments on the impact of NARS on production.

## NARS Impact on Production

The monographs provide limited information on the impact of AR on agricultural production, which is a rather complex issue.

- In Algeria, the relatively high increase in national agricultural production observed since 1980 is certainly due less to technical innovations proposed by the NARS institutions than to other factors (privatization of the socialist and cooperative farms, liberalization of agricultural marketing, easier imports of inputs and technologies).
- In Morocco, INRA claims the release of about 65 cultivars of various cereals, forages and food legumes, now marketed by the National Seeds Marketing Society.
- In Tunisia, technologies developed by the NARS that have been successfully adopted include improved cultivars of cereals, legumes, vegetables, and fruit trees; biological and chemical control of plant diseases; better utilization of annual feed resources; and improved local sheep breeds. However, it is difficult to obtain an inventory of research output, or to evaluate the impact of research on agricultural development. This aspect may be explained by the lack of evaluation of research output. The technologies generated appear to be more readily adopted by large-scale farmers, agricultural development agencies, rural development societies, and state and cooperative farms, rather than by the majority of medium- and small-scale farmers.
- In Egypt, the impact of AR on production is difficult to estimate as progress in production results also from many other factors and from the agricultural reform policies. What is sure is that without AR support and results, the large increases in the yields of major crops (wheat, maize, rice, etc.<sup>1</sup>) observed during the last 10 years would not have taken place, and prospects of the national food balance would not have changed so dramatically. According to 1994 statistics, the food gap for grain by the year 2000 was estimated at 4.5 million tons, against 26 million tons according to 1982 statistics, recording a reduction of about 83%.
- In Syria, it is well recognized that AR has contributed significantly (along with other national public services and public and private organizations) to national agricultural development, which has been rather good over the last 10 years; the AGDP has registered 50% growth during the period 1985–1995. The impact of AR has been important in some areas such as field crops (cereals, food legumes, fruit, etc.) and cotton (Syria has the highest yields in the world).
- In Turkey, GDAR has provided valuable research output to the nation's agriculture, mainly in plant breeding and crop management and protection, where it has a relatively well-trained scientific cadre and adequate research facilities. In addition, it has a core group of qualified research staff and a growing research capacity in plant genetic resources conservation. However, GDAR's research potential and past accomplishments have been rather limited in animal breeding, husbandry, health, and fisheries.
- In Yemen, in spite of the many constraints and weaknesses, AR activities seem to have met some of the development objectives of the country; for example, self-sufficiency in vegetables and fruits has been achieved.

Most of the previous observations and verbal statements made by NARS leaders suggest that AR has had a rather significant positive impact on agricultural development. To date, there have been no formal studies related to the impact of NARS on agricultural production at the national level; only a very limited number of studies have been conducted on some commodities in a few countries (mainly Egypt and Turkey). These studies, based on *ex post facto* benefit-cost analysis of technologies, have generally demonstrated the high profitability of AR programs; however, most of these studies (and the similar ones carried out in other regions/countries of the world) are questionable, as they often underestimate the research costs and overestimate the benefits, thus overestimating AR profitability which might be positive but not as high as calculated<sup>2</sup> or suggested.

<sup>1</sup> The national yields for wheat, maize, and rice have increased from 3.20, 4.13 and 5.70 t/ha in 1982 to 6.07, 7.88 and 8.33 t/ha, respectively, in 1995.

<sup>2</sup> Most of these studies do not take into account (or, instead, they minimize) such factors as (i) the indirect costs (common research charges, costs of other national and foreign research work useful for advancing the program) throughout the duration of the program, and (ii) the depreciation of human investment (cost of staff training) developed before the conception and start of the program. Regarding the benefits, the studies allocate them essentially to research, and they underestimate the role of other important components of the extension process (agricultural extension; agricultural and general training; infrastructure, such as dams or new or improved roads, etc.). They also ignore some problems related to the negative impact of agricultural growth on natural resources (for example, the decrease of water reserves, soil pollution). For a severe criticism of these *ex post facto* AR benefit-cost analyses, see Montes-Llamas (1986) and Casas/FAO (1999).



At this point, an interesting observation is worth noting. Referring to the agricultural production growth indices (total or per capita) of 1996 compared to those of 1980 (estimated by FAO, see Table 4, Chapter 2), it may be concluded that there is no obvious relationship between both the features of the NARSs and the research–development linkages, as described above, and the performance of national agriculture (except probably in the very long term). This may be seen from the following:

- Some countries with NARSs that have numerous and acute deficiencies have had rather good agricultural growth; among them are Iran (FAO indices: total = 221; per capita = 128), Algeria (FAO indices: total = 196, per capita = 126), and Syria (FAO indices: total = 167, per capita = 93<sup>1</sup>).
- Other countries with better-structured and endowed NARSs have had lower performance: Egypt (FAO indices in 1996: total = 181, per cap. = 123), Turkey (FAO indices: total = 140, per capita = 100), Ethiopia (FAO indices: total = 138, per capita = 88), Cyprus (FAO indices: total = 105, per capita = 83), and Eritrea (FAO indices: total = 103, per capita = 88).

As a final word, with a few exceptions, most of the NARSs in the WANA region may have actually achieved until present only modest impact on national agricultural development due to the above-mentioned shortcomings and constraints related to the NARSs, national development organizations, and farmers' conditions and environment. The NARSs are not responsible alone for such a situation; the deficiencies in agricultural policies and the socioeconomic underdevelopment in most countries do not generally provide favorable circumstances for agricultural research and development and dissemination of innovations. Such considerations lead to the final conclusion.

## 9.5 CONCLUSION

The above analysis showed the diversity of the NARS profiles in terms of structure, resources, research activities, and productivity, which reflects the diversity of the countries themselves. Despite this diversity, some common issues have been outlined, which deserve further attention within a historic perspective.

The NARSs are relatively young. They have been progressively set up in countries which got their full formal independence and self-governance after the Second World War, and even much more recently for some countries. Most of these countries have experienced difficult “political” periods and changes at the time of independence or later, and have generally had other priorities than agriculture and research. Most of the NARSs have experienced very rapid growth. Although this has inevitably given room to understandable mistakes, it has created experience and maturity at the same time. This now warrants future improved evolution.

Thus, most of the NARSs have suffered unstable changes in their environment over the years. In some countries, the national authorities governing the NARS institutions have changed too often, frequently as a result of governmental and political considerations, and sometimes, if not often, as a result of reasons that are far from being organizational or scientific. Such unstable environments have induced instability in the NARS structures, resources, and scientific and administrative leadership. However, it seems that such unstable environments have become less and less damaging as most countries now have one or two well-established, dominant ARIs, generally affiliated to a ministry of agriculture. These ARIs are endowed with highly qualified staff, which makes the NARSs less vulnerable to political changes.

The growing numbers of NARS institutions is a feature in all countries. In the past, and until present for some NARSs, ARIs and their researchers suffered discrimination compared to the FASs and their academic staff members. This was, and still is, understandable in the “younger” countries, where priority was given to educating graduate staff members who were a rare resource in the past. But the situation has changed in most countries, where public institutions specialized in administration and development are now (or are starting to be) endowed with sufficient numbers of graduates, even if the level of their qualifications remains questionable (see below). Therefore, the allocation of scientists at the ARIs is no more a sensitive issue, except when career and salary schemes are still much less favorable than at the FASs and some other public institutions, and may discourage recruitment and stability of the best researchers. Fortunately, ARIs in many of the NARSs have recently implemented some positive changes in this domain, and can now attract, train, and retain motivated and qualified researchers. Regarding other human resources, the problem of recruiting technicians and other qualified support staff has almost never been taken into consideration, despite the fact that these categories of staff have a highly significant role on the scientists' efficiency.

The unbalanced allocation of human and physical resources is a major issue in many NARSs; the lack or scarcity of permanent scientific and technical staff in vast regions of each country, which are often the less favorable

<sup>1</sup> Most of the total growth has been registered within the last 10 years.

agroecological zones and farming systems, results in inadequate research activities and relations with development organizations in those regions. This situation reflects the unbalanced national socioeconomic development policies which have generally paid more attention to urban development and to rural areas closer to the capitals and large cities. Things are also improving in this domain, albeit rather slowly. Now, within the framework of large political and economic decentralization processes which would allow more balanced regional development, and through the preparation of national AR strategic plans, NARSs should improve the territorial allocation of their resources.

Most of the NARS leaders have complained about insufficient financial resources, especially the small operation and capital budgets, considered as the most limiting factor to research efficiency. However, data presented in most of the monographs show that such a situation may be improved if certain issues are taken into consideration. In many NARSs, it seems that: (i) the number of scientists or researchers could be reduced without affecting the productivity of research, as their actual employment rate is often rather low; (ii) employees with low qualifications (laborers, drivers, etc.) are rather numerous; and (iii) the networks of research centers, stations, and farms are oversized and could be rationalized and made less expensive.

Research activities are still frequently subject to many deficiencies, such as their inadequate quality due to the rather low qualifications of the scientists (at the ARIs), unbalanced coverage of scientific domains and regions, lack of monitoring and assessment, and limited international scientific cooperation, especially among the WANA NARSs. However, the main ARIs are aware of these deficiencies and are progressively overcoming them through intensive training efforts; preparation of national strategic AR plans or ARI master plans; and dynamic relations with regional and international AR centers and organizations, particularly FAO, ICARDA, ACSAD, AOAD, and CIHEAM, which have contributed considerably to strengthening agricultural research and capacity building in the WANA countries, in addition to enhancing coordination at the national and regional levels. All these efforts are paving the road for more active and balanced relations within the region.

Linkages with public and private development organizations are also concerns of the main ARIs, which have already set up diversified channels for intensifying them. As seen above, the improvement of these linkages may rely on further changes within these organizations and in the national agricultural policies.

Finally, scientific results and impact on agricultural production may seem rather modest when the large amounts of resources allocated to the NARSs are taken into account, but this issue may be considered within a long-term perspective. Most of the NARSs have almost completed the stage of quantitative growth and are now entering into the era of consolidation.

For the future, the major challenges to the NARSs will be the appropriate balance with their partner organizations—public agricultural administrations, public and private development organizations, and farmers' unions—which apparently are facing more acute problems of management and resources. Countries certainly need well-organized and efficient NARSs, but such NARSs can not serve their purpose without partners having the same features. This issue may require the NARSs to pay higher attention to certain activities that could reinforce these partner organizations (such as training of their senior staff and leaders and temporary transfer of researchers to these organizations) and to some research domains which would help development and farmers' organizations to better understand their own situation, such as multidisciplinary research on farming systems and also research on sociology focussed on rural communities and organizations.

#### **Acronyms of the NARS Institutions Mentioned in the Text and Tables**

Algeria: ENASA: Ecole Nationale des Sciences Agronomiques (Alger). INRAA: Institut National de la Recherche Agronomique d'Algérie. DFRV: Directorate of Training, Research and Extension.

Libya: ARC: Agricultural Research Center. ASRC: Animal Studies and Research Center. MBRC: Marine Biology Research Center.

Morocco: ENA: Ecole Nationale d'Agriculture de Meknès. IAV Hassan II/Rabat: Institut Agronomique et Vétérinaire Hassan II. INRA: Institut National de la Recherche Agronomique. INRH: Institut National de Recherche Halieutique. DERD: Directorate of Education, Research and Development).

Tunisia: INAT: Institut National Agronomique de Tunis. INRAT: Institut National de la Recherche Agronomique de Tunisie. IRESA: Institution de la Recherche et de l'Enseignement Supérieur Agricoles.

Egypt: ARC: Agricultural Research Center. DRC: Desert Research Center. NARC: National Agricultural Research Council. NARP: National Agricultural Research Project. NIOF: National Institute of Oceanography and Fisheries. NRC: National Research Center.

Entrea: CAAS: College of Agriculture and Aquatic Sciences of the University of Asmara (UOA). DARHRD: Department of Agricultural Research and Human Resource Development.

Ethiopia: EARO: Ethiopian Agricultural Research Organization. IAR: Institute of Agricultural Research.

Sudan: ARC: Agricultural Research Corporation. ARRC: Animal Resources Research Corporation.

Cyprus: ARI: Agricultural Research Institute.

Iraq: SBAR: State Board for Agricultural Research. CWSR: Center for Water and Soil Research.

Jordan: NCARTT: National Center for Agricultural Research and Technology Transfer. UOJ: University of Jordan (Amman). WERSC: Water and Environment Research and Study Center.

Lebanon: LARI: Lebanese Agricultural Research Institute.

Syria: DASR: Directorate of Agricultural Scientific Research. DCB: Directorate of Cotton Bureau. DIWU: Directorate of Irrigation and Water Use. DS: Directorate of Soils.

Iran: MOJC: Ministry of Jihad Construction. MOC: Ministry of Commerce. MOH: Ministry of Health. AREFO: Agricultural Research, Education and Extension Organization.

Turkey: GDAR: General Directorate of Agricultural Research. GDRS: General Directorate of Rural Services. ARI: Agricultural Research Institute. HCA: High Council of Agriculture (MARA).

Bahrain: ARD: Agricultural Research Directorate.

United Arab Emirates: ARC: Agricultural Research Center of the MAF Department of Agriculture and Animal Husbandry, Al-Ain. ARD: Agricultural Research Directorate of the MAF Department of Research and Plant Production.

Yemen: AREA: Agricultural Research and Extension Authority.

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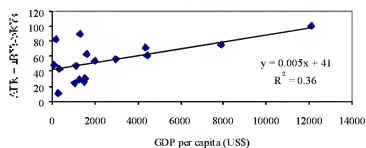
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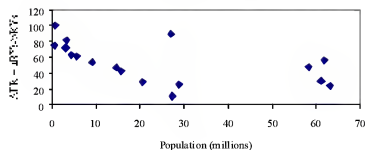
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Annex 9.1 - Figs 1 to 7

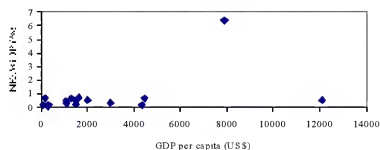
**Fig. 1 - The WANA NARSs: Actual Employment Rate (aRYs/pRYs) in Relation to GDP per Capita**



**Fig. 2 - The WANA NARSs: Actual Employment Rate (aRYs/pRYs) in Relation to Population of the Countries**



**Fig. 3a - The WANA NARSs: Ratio of National AR Expenditures (NE) to AGDP in Relation to GDP per Capita**



**Fig. 3b - Same as Fig. 3a, but using a larger scale and without Bahrain and Cyprus (GDP/capita: US\$ 7,890 and 12,100, respectively)**

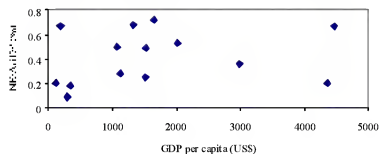


Fig. 4 - The WANA NARS: Number of pRYs per Million Agricultural Laborers in Relation to GDP per Capita

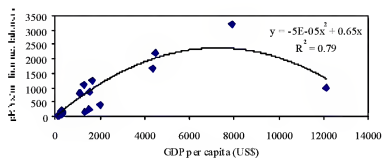


Fig. 5 - The WANA NARS: Number of aRYs per Million Agricultural Laborers in Relation to GDP per Capita

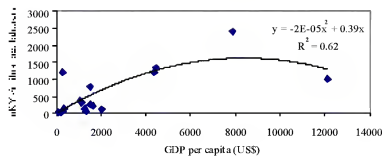


Fig. 6 - The WANA NARS: Ratio of National AR Expenditures (NE) to Million Agricultural Laborers in Relation to GDP per Capita

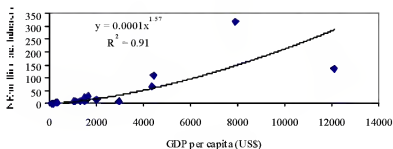
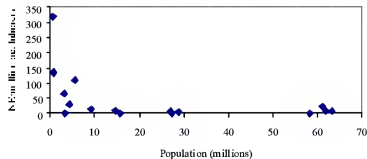


Fig. 7 - The WANA NARS: Ratio of National AR Expenditures (NE) to Million Agricultural Laborers in Relation to Population of the Countries





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